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ABSTRACT

Designed to assist practitioners of both formal and non-formal settings, this 18th volume of the ERIC Clearinghouse for Science, Mathematics, and Environmental Education's Teaching Activities in Environmental Education series specifically focuses on the theme of hazardous and toxic materials. Initially, basic environmental concepts that deal with hazardous and toxic materials are listed and are referenced by the page number of the activities where they are addressed. A synthesis of the federal legislation related to hazardous substances is presented and management options are discussed. A general outline of the classification scheme used in the guide is provided and the number of activities according to each grade level, subject area, and focus area is specified. The teaching activities are grouped by suggested grade levels (K-3; 4-6; 7-9; and 10-12). Information on each activity includes: (1) purpose; (2) grade level; (3) focus area (general, health, water, air, biological aspects, disposal, and social/political aspects); (4) subjects (science/health, social studies, mathematics, language arts, fine arts, and home economics); (5) concept; (6) references; and (7) actual activity (including materials which can be duplicated). A listing of 32 references is also provided. (ML)

ED273432

SELECTED AND DEVELOPED BY

JOHN F. DISINGER AND MARYLIN LISOWSKI

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TEACHING ABOUT HAZARDOUS AND TOXIC MATERIALS

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ERIC Clearinghouse for Science, Mathematics and Environmental Education
The Ohio State University
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Columbus, Ohio 43212

December 1985

ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for these publications are invited.

John F. Disinger
Associate Director
Environmental Education

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PREFACE

This is the 18th volume in ERIC/SMEAC's Teaching Activities in Environmental Education series, which was initiated in 1973. The first three titles in the series were of a general nature, dealing with multiple aspects of environmental education. Starting with the fourth, topical areas have been identified as themes, with the expectation that such an organizational pattern might prove more useful to practitioners in both formal and non-formal settings.

As a general rule, most of the activities selected for inclusion in the various volumes have been adapted from materials developed by others; many of the source publications have been reported through the ERIC data base, and are available as ERIC documents. Some have been "original," in the sense that ERIC staff or other authors have developed them more or less from scratch. Common formats have been employed for all activities in each volume.

The current volume was developed by John F. Disinger and Marylin Lisowski. Most of the activities are based on reports, instructional materials, and other information located through the ERIC system, as referenced. Activities include a mix of original and adapted materials.

Other titles in the Teaching Activities in Environmental Education series include:

John H. Wheatley and Herbert L. Coon, One Hundred Teaching Activities in Environmental Education. 1973; ED 091 172; 204 pages.

John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume II. 1974; ED 102 031; 200 pages.

John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume III. 1975; ED 125 268; 195 pages.

Herbert L. Coon and Michele Y. Alexander, Energy Activities for the Classroom. 1976; ED 130 833; 148 pages.

Herbert L. Coon and Mary Lynne Bowman, Environmental Education in the Urban Setting: Rationale and Teaching Activities. 1977; ED 137 140; 199 pages.

Judith M. Schultz and Herbert L. Coon, Population Education Activities for the Classroom. 1977; ED 141 178; 195 pages.

Robert H. McCabe, J. Terence Kelly, and Doris Lyons, Man and Environment Teaching Activities. 1977; ED 144 626; 336 pages.

Herbert L. Coon and Charles L. Price, Water-Related Teaching Activities. 1977; ED 150 026; 156 pages.

Mary Lynne Bowman and John F. Disinger, Land Use Management Activities for the Classroom. 1977; ED 152 541; 265 pages.

Mary Lynne Bowman and Herbert L. Coon, Recycling: Activities for the Classroom. 1978; ED 159 075; 145 pages.

William R. Hernbrode, Multidisciplinary Wildlife Teaching Activities. 1978; ED 162 897; 95 pages.

Herbert L. Coon and Mary Lynne Bowman, Energy Activities for the Classroom, Volume II. 1978; ED 173 072; 165 pages.

Mary Lynne Bowman, Values Activities in Environmental Education. 1979; ED 182 118; 134 pages.

Charles E. Roth and Linda G. Lockwood, Strategies and Activities for Using Local Communities as Environmental Education Sites. 1979; ED 194 349; 207 pages.

Mary Lynne Bowman, Teaching Basic Skills through Environmental Education Activities. 1979; ED 196 704; 132 pages.

Mary Lynne Bowman, Teaching Natural Resources Management through Environmental Education Activities. 1981; ED 214 752; 206 pages.

Lori D. Mann and William B. Stapp, Thinking Globally and Acting Locally: Environmental Education Teaching Activities. 1982; ED 229 214; 327 pages.

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Marylin Lisowski is a candidate for the Ph.D. degree in science/environmental education in the Department of Educational Theory and Practice of The Ohio State University, and a Research Associate for the ERIC Clearinghouse for Science, Mathematics, and Environmental Education. She holds a B.A. degree from Carlow College and an M.A. from The Ohio State University, and has been a science teacher in private and public schools in Ohio and Florida, having been named "Outstanding Science Teacher of the Year" in Ohio and "Honor Science Teacher of the Year" in Florida.

BASIC CONCEPTS DEALING WITH HAZARDOUS AND TOXIC MATERIALS

The following conceptual statements have been derived from those presented by Robert E. Roth, et al., Environmental Management Concepts--A List, Technical Report No. 126, Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, Madison, WI, April 1970. ED 045 376.

1. Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.
   pp. 65, 88, 107, 164, 177, 178, 231, 240, 245, 247, 248.

2. Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.
   pp. 5, 21, 65, 71, 98, 104, 157, 164, 207, 231, 240, 253.

3. Environmental management is the result of the rational application of scientific and technical knowledge to achieve particular objectives.
   pp. 157, 175, 177, 239.

4. Certain risks are taken and limitations experienced when manipulating the natural environment.
   pp. 36, 45, 46, 52, 127, 130, 131, 134, 137, 141, 201, 235, 248.

5. Increasing human population, higher standards of living, and resultant demands for greater industrial production promote increasing environmental contamination.
   pp. 24, 124, 145, 217.

6. Pollutants and contaminants are produced by natural and man-made processes.
   pp. 3, 12, 25, 29, 43, 44, 50, 52, 68, 73, 88, 90, 121, 124, 127, 137, 140, 161, 181, 197, 201, 211, 220, 225.

7. In many cases, alternative procedures or substitute materials may be used to avoid problems inherent in the use and/or disposal of hazardous and toxic substances.
   pp. 21, 37, 76, 82, 185.

8. Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.
   pp. 9, 30, 58, 68, 132, 177, 178, 189, 201, 214, 222, 233, 235, 239, 240, 245, 247, 248.

CLASSIFICATIONS OF ACTIVITIES

Grade Level:	K-3	4 activities
	4-6	13 activities
	7-9	28 activities
	10-12	20 activities
*Subject Area:	Sciences/Health	64 activities
	Social Studies	16 activities
	Mathematics	2 activities
	Language Arts	3 activities
	Fine Arts	4 activities
	Home Economics	4 activities
Focus:	General Aspects	14 activities
	Health Aspects	10 activities
	Hazardous Materials in the Water	7 activities
	Hazardous Materials in the Air	12 activities
	Biological Aspects	6 activities
	Disposal of Hazardous Materials	17 activities
	Social/Political Aspects	6 activities

*Some activities fall into more than one subject area.

INTRODUCTION

Air quality and surface water quality were the initial concerns of the present environmental movement, because they are obvious and dramatic. Generally, other waste and hazardous materials concerns received attention in terms of the aesthetic aspects of their presence, in terms of littering or unsightly disposal sites. The concept and practice of underground disposal of both solid and liquid waste materials were generally accepted, even promoted -- out of sight, out of mind. It has taken major events such as the Love Canal, Three Mile Island, and Bhopal "incidents" to bring hazardous substances problems forward as necessary, and demanding, for attention. For example, a recent report by the Comptroller General of the United States (1985, p. 1) begins with this statement:

> "Addressing the problems related to the handling of hazardous substances has become a national concern. Hazardous substances can seep into groundwater supplies, contaminate land, and escape into the air, thereby posing real or potential threats of damage to human health and to the environment."

Federal programs dealing with hazardous substances, including their disposal, were initiated by the Solid Waste Disposal Act (SWDA) of 1965; the Resource Recovery Act (RRA) of 1970; the Safe Drinking Water Act (SDWA) of 1974; the Toxic Substances Control Act (TSCA) of 1975; the Resource Conservation and Recovery Act (RCRA) of 1976; the Comprehensive Response, Compensation, and Liability Act (Superfund) of 1980; and the Nuclear Waste Policy Act (NWPA) of 1982. All acts but one focus on waste materials; TSCA addresses the regulation of the more than 43,000 chemicals identified by the U.S. Environmental Protection Agency (EPA) as potentially hazardous to human health (Baldwin, 1985, p. 185). EPA anticipates the addition of thousands of additional chemicals to the list; the current rate of addition is on the order of 1000 per year.

What Laws Deal with Waste Disposal?

The other laws noted above all deal with handling of waste materials, with increasing emphasis over the years on hazardous wastes. SWDA (1975) marked the beginning of the federal government's assumption of a major role in the problem of solid waste, providing federal leadership in research, training, demonstration of new technologies, technical assistance, and grants for state and interstate solid waste planning programs. It concentrated on the concept of conserving natural resources by reducing waste and unsalvagable materials and by solid waste recovery. RRA (1970) emphasized recycling, authorizing funds for demonstration grants for recycling systems and for studies of methods to encourage resource recovery, and required EPA to publish guidelines for construction and operation of solid waste systems. These guidelines are binding on federal agency operations and on federally funded projects (Frost, 1985, p. 27).

EPA's definition of hazardous waste includes waste substances which are flammable, corrosive, reactive, or toxic (U.S. General Accounting

Office, 1985, p. 1). EPA has compiled a list of 361 chemicals in 16 categories that pose hazards if improperly discarded (Council on Environmental Quality, 1980, pp. 190 ff.); examples include acids, bases, heavy metals, solvents, pesticides, phenols, methane, polychlorinated biphenyls (PCBs), disease agents, and radioactive isotopes.

SDWA's (1974) purpose is to protect the nation's drinking water by establishing federal standards for substances which may be adverse to human health and to protect underground water supplies by controlling injection of wastes (Frost, 1985, p. 23).

A basic thrust of the RCRA (1976) provisions for hazardous waste management was to establish requirements for the safe treatment, storage, and disposal of hazardous waste. Under the Act, EPA promulgated design and operating requirements for the nation's approximately 5000 treatment, storage, and disposal facilities.

What is the Purpose of Superfund?

Superfund (1980) was designed to provide for cleanup of the nation's hazardous waste disposal sites, of which EPA has estimated there are more than 18,000 across the country. Included among such sites are abandoned facilities, midnight (illegal) dumps, transportation-related spills, and incineration plants. Superfund was necessary because previous legislation made no allowance for abandoned facilities; it also increased specificity of requirements.

What Management Options Are Available?

Frequently, hazardous wastes are placed in drums, tanks, or other containers, in lagoons or pits, or are scattered or poured on the ground, or are buried. The problem with all of these techniques is the lack of long-term containment; containers may rupture or corrode, lagoons or pits are not sealed permanently, and in all cases the wastes may pollute the soil and, more insidiously, groundwater. Not enough is known about groundwater movement to permit development of a complete assessment of the dangers of such pollution. What is known points clearly to both short-term and long-range negative effects on environmental quality and human health.

The ideal management choice of dealing with hazardous wastes is to lessen quantities generated--by altering industrial processes, industrial outputs, and consumer behavior (Baldwin, 1985, pp. 193 ff.). Once generated, hazardous wastes must be either disposed of or stored. EPA's recommended priorities for waste disposal include recovery and recycling as the preferred alternative, followed by reprocessing (making hazardous wastes less hazardous), then by incineration. For storage, EPA's prioritized alternatives include, in order, deep well injection, solidification and encapsulation, and (as a last choice) disposal in a secure landfill.

What Teaching Materials Are Available?

Teaching about hazardous materials presents many of the same problems as does teaching about environmental concerns in general. Identification of the proper location, or locations, to include such teaching within an existing curriculum is difficult. Locating up-to-date, accurate information and teaching aids useful in such an endeavor is time-consuming, and sometimes appears fruitless. Parallel to public perceptions of solid waste problems, many educational materials in the general area deal with litter, basically from an aesthetic perspective. Educators have generally followed the public perception that "if we don't see them, they (waste materials) are not a problem."

Again as is typical of environmental topics, most of the available teaching materials dealing with hazardous substances stress either the scientific aspects of the problem or the need for institutional (primarily governmental) responses to them. Thus, teaching about hazardous materials is properly a concern for both science and social studies instruction -- and is likely to be incomplete if either aspect is omitted or short-changed. It is to be hoped that developing emphases on science/society/technology/environment teaching and learning will help alleviate this situation.

Nonetheless, teaching materials dealing with hazardous and toxic substances have been and are being developed; a number of them have been announced, and are available, through the ERIC system. This volume contains a selection of such materials which have been adapted to a common format, consistent with the formats of earlier publications in the ERIC/SMEAC Environmental Education Teaching Activities series. In addition, several "original" activities--original in the sense that they are based on published information, not on other classroom-oriented materials--are included. They were not, however, created from whole cloth.

By providing these activities, the authors wish to assist educators, in schools and out of schools, in beginning and/or advancing their efforts directed toward learning related to hazardous and toxic materials. There is much more already available than is contained within these pages; hopefully, this volume will facilitate locating such instructional materials. More importantly, educators should be encouraged to adapt and/or design their own instructional materials in whatever formats and for whatever contexts make the most sense for those whose learning they guide.

John F. Disinger
Marylin Lisowski

December 1985

HAZARDOUS AND TOXIC MATERIALS

TEACHING ACTIVITIES

GRADES K-3

A WORD PUZZLE

PURPOSE: To identify terms associated with hazardous materials.

LEVEL: K-3

FOCUS: General Aspects

SUBJECTS: Health
Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

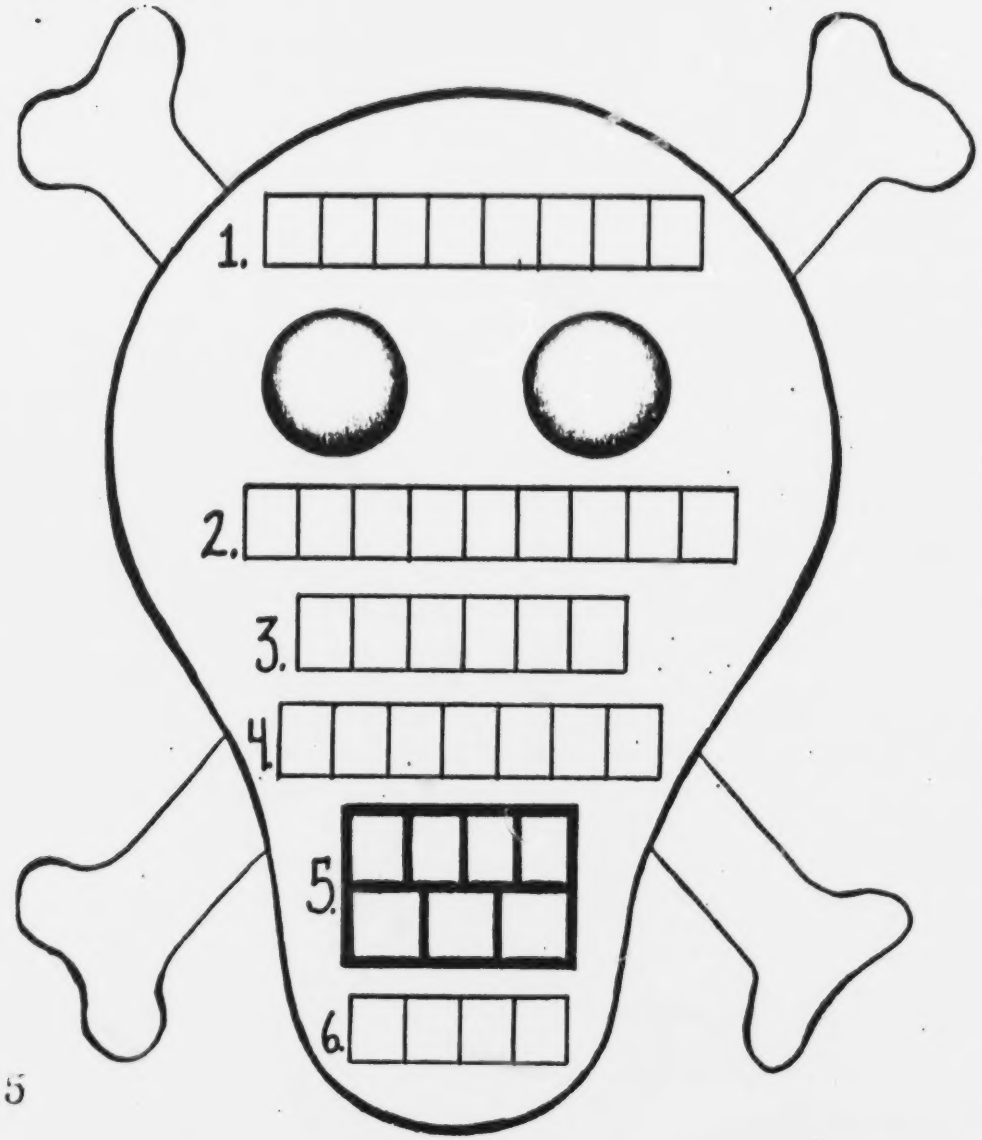
REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades K-3. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 6-7. ED 266 948.

ACTIVITY: Provide a copy of the worksheet (page 4) to each student. Tell them that they are going to talk about some words and what they mean.

Read each clue aloud. After reading each clue, read the "words to use." Then ask for the answer.

Assist children in finding the answers by providing hints or by reading only those words left after each clue is answered.

WORDS TO USE: children, dangerous, poison, warning, keep out, safe.



Word Puzzle

CLUES

1. Boys and girls.
2. Could hurt you, means "not safe".
3. Something that can make you very sick.
4. Means "watch out" or "be careful".
5. Stay away.
6. Okay, will not hurt you.

WORDS TO USE

warning	keep out	poison
children	dangerous	safe

TASTE NOT, TOUCH NOT

PURPOSE: To learn the differences between items that are safe to eat and handle, and those which are not.

LEVEL: K-3

FOCUS: Health Aspects

SUBJECTS: Health
Science
Fine Arts

CONCEPT: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades K-3. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 46-49. ED 266 948.

BACKGROUND: Poisonous items can be mistaken for food items. A display of four or more of the items mentioned below (LOOK ALIKES) should be set up. The teacher will need to determine whether or not children can smell the products of this exercise; they may want to consider the possibilities of allergic reactions. One or two products should be placed in beverage or food containers (cups, soda bottles, etc.). Make certain that the containers are capped or covered with plastic.

LOOK ALIKES

NOT SAFE	SAFE
Moth Crystals	Rock Candy
Ant and Roach Paste	Peanut Butter
Bleach, Drain Opener	Water
Slug Killer	Cereal
Disinfectant	Apple Juice
Red Furniture Oil/Finisher	Cherry Soda
Detergents	Powdered Milk
Lemon Furniture Oil	Lemon Soda
Mothballs	Marshmallows (small size)
Radiator Flush	Canned Soda (use unfamiliar brand)
Medicine in Tube	Toothpaste (use unfamiliar brand)
Pills (colored)	Candy

ACTIVITY 1:

1. Tell the children that today they are going to learn how some unsafe products can fool them into believing they are safe.

2. Tell the children that things are not always what they seem to be. Show the children the display of unsafe products. Keep the safe products out of sight. Tell the students you want them to look at the display and guess what the products are. Have the children file by and look at the display. (No touching. Teacher should decide if students will be allowed a brief "smell.") When the children are back in their seats, point to the products--one at a time--and ask what they "look like." Encourage the children to expand their answers such as, "It's in a soda bottle so it must be safe to drink," (In reality, the "soda" may be furniture oil). "It looks like candy but I've never tasted that kind before," etc. Accept all answers. If a child guesses the actual unsafe product, don't say that the child is right, just accept the answer along with all the rest and continue to ask what else the product "looks like."

3. When all the products have been discussed, tell the children that the products just fooled them (or some of them). Tell the children what each product really was and bring out its safe "look alike." Ask the children <u>how</u> they were fooled by the unsafe product. Emphasize <u>how</u> the unsafe product fooled them, e.g., the color of the product, the shape of the product, the bottle it was in, etc. After discussing the safe/unsafe products, be sure to put them away in a locked cupboard. If you have the products brought out to your car, make sure you do not store any aerosols in a hot trunk or direct sunlight. Aerosols can explode under pressure and high heat.

4. Tell children that because some unsafe products can fool them, it is important not to ever put anything in their mouth unless an adult gives them permission. This means they should never eat things that they find on the ground or laying around the house.

5. Tell the children they are going to learn a little song about what they should do before eating things they find on the street or somewhere in their house, etc. Ask the children if anyone knows the answer (i.e., does anyone know what they should do before eating or drinking something that was not given to them by an adult?).

If no one gives the answer say, "We must ask before we eat it" and that's what the song is all about.

The song is sung to the tune of "Three Blind Mice." Students and teacher may alternate lines as given below:

"WE ASK FIRST	teacher
WE ASK FIRST	students
WHAT WE MAY TASTE	teacher
WHAT WE MAY TASTE	students
EVEN THOUGH GOODIES	teacher
LOOK EVER SO GOOD	teacher
WE HAVE TO REMEMBER	teacher
AS WISE CHILDREN SHOULD	teacher
NOT TO PUT ANYTHING	teacher
INTO OUR MOUTHS	teacher
TILL WE ASK FIRST!"	teacher and students

The teacher should tell the students they are going to play a game called "just suppose." The teacher should give the class a scenario and let them say what they would do. The scenarios could be as follows:

1. Just suppose you were playing with a friend and you saw him/her pick something up off the floor and put it in his/her mouth. What would you do? Tell why.

2. Just suppose you went into your garage after mommy/daddy finished painting a cupboard and you saw an open soda bottle near an empty paint can. You were very thirsty and the soda bottle looked like it was full. What would you do? Tell why.

3. Just suppose you went into the bathroom of your home and found some tasty looking things in an opened container. You were hungry for some candy and this looked like the stuff you had last week. What would you do? Tell why.

4. Just suppose you were thirsty and found a soda bottle where mommy/daddy keeps the furniture polish. What would you do? Tell why.

5. Just suppose you were playing in the back yard with your baby brother and you saw him put something in his mouth. It looked like food but you weren't sure and mom had just finished putting some poisons out to kill some garden bugs. What would you do? Tell why.

ACTIVITY 2: Pass out "Taste Not - Touch Not" worksheet. Have children color those products that are safe to eat. Put an X over those things that are not safe to eat.

TASTE NOT, TOUCH NOT

Put an "X" over unsafe products.
Color what is safe to eat or drink.

UNSAFE WASTE DISPOSAL

PURPOSE: To demonstrate that unsafe disposal of potentially dangerous materials can cause injuries and illnesses.

LEVEL: K-3

FOCUS: Health Aspects; Disposal of Hazardous Materials

SUBJECTS: Health
Science

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades K-3. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 50-55. ED 266 948.

ACTIVITY:

1. Tell the children that they are going to learn where trash goes after it is thrown in the "garbage can" and that they will also learn about some dangerous things found in the trash. First, however, introduce them to Paper Pete (directions on page 11).

2. Have the children and puppet enter into a dialogue that goes something like this:

Puppet: Hi. I'm Paper Pete. Every day I get thrown in trash containers after I've been used by people. Can you name some ways that people use paper?

Children: To draw on, to write on, to make airplanes, to figure out math problems, etc. (Accept all reasonable answers.)

Puppet: That's right! And when they are through using the paper, where does it go?

Children: The trash! It gets burned! It goes to the dump!, etc.

Puppet: Right again. Sometimes it's even used over again by other people. This is called recycling the paper.

Today we're going to talk about things that are dumped in the trash. Who can name some things that end up in the garbage can?

Children: Paper. Banana peels. Boxes. Pencils. (Try to get the children to mention some hazardous items such as razor blades, broken glass, pills, aerosols, acid, etc.)

Puppet: Right! Lots of things are thrown in the trash and it's hard to tell it's there because some dangerous things, like broken glass or razor blades, can hide under bigger things like boxes and paper. That's why we should never play with things found in the trash or snoop around in it. We could hurt ourselves. Do you know of anyone that was hurt by playing with something they found in the trash?

Children: Give children time to answer the question. If there is no response (or when children are finished), Paper Pete relays his own story.

Puppet: I saw a little boy get very sick when he ate some pills that he thought were candy. They were in a pretty jar just sitting on top of all the garbage. He was hungry and they looked good. Then there was the little girl who cut her hand on some broken glass that was hiding in the bottom of the trash can. She wanted to see if the trash contained any "treasures" that she could use. I also remember how a puppy got very sick when it drank from a puddle on the street. The puddle had antifreeze in it. Antifreeze is used to keep car engines working right and it tastes very sweet to animals. It is also very dangerous to drink.

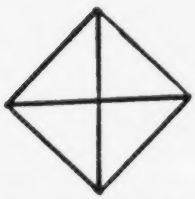
I want you all to stay well and healthy. Please don't touch things that are thrown in the trash.

Finger Puppet Directions

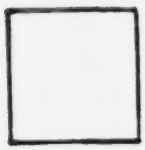
FOLD CORNER TO CORNER, THEN REOPEN.

FOLD OPPOSITE CORNER TO CORNER, REOPEN.

FOLD ALL CORNERS TO THE MIDDLE.

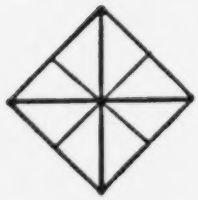


IT SHOULD LOOK LIKE THIS.



TURN OVER TO SMOOTH SIDE.

FOLD ALL CORNERS TO THE MIDDLE.



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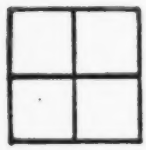
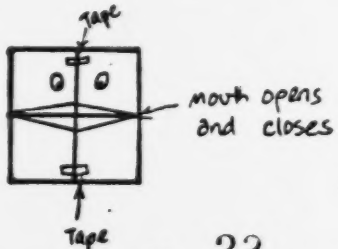


TURN OVER SO IT IS UP ON THE SIDE THAT LOOKS LIKE THIS.

THEN, CAREFULLY PLACE YOUR FINGERS INSIDE ALL FOUR SQUARE FOLDS AND MOLD INTO A FINGER PUPPET. AFTER THE PUPPET IS IN WORKABLE FORM, IT IS EASIER TO OPERATE IF YOU TAPE TWO SIDES (OPPOSITE EACH OTHER) DOWN. YOU MAY THEN DRAW IN EYES, COLOR MOUTH, ETC.



TOXIC SUBSTANCES IN THE HOME

PURPOSE: To demonstrate that common household products must be safely used and stored, or they will present threats to health.

LEVEL: K-3

FOCUS: Health Aspects

SUBJECTS: Science
Health
Fine Arts

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 4-6. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 40-45. ED 266 949.

MATERIALS NEEDED:

1. Coloring book, pages 14-17, stapled together. (One per student.)
2. Crayons
3. Construction paper or plain white sheets of 8 1/2" x 11" paper.

ACTIVITY 1: Each page of the coloring book should be discussed and the information on the page read orally. Pages could be colored later or at home. Hand out the coloring books to each child.

Page 14 - Discuss what is safe and what is dangerous for baby to eat in the kitchen. Ask the children how the baby might get hurt by the household cleaners. (EXAMPLES: the baby might be thirsty and drink the bleach and get sick; the baby might spray the oven cleaner in his/her eye and it will burn.) Have the children put an X on the cleaners. Discuss ways to keep the baby away from the cleaners (e.g., lock the cupboard doors, put the cleaners on a high shelf, keep the cleaners in the garage on a high shelf). Read the information on page 14 orally. Color.

Page 15 - Discuss how weed and bug sprays are poisons and can make people and pets sick. (EXAMPLES: Children playing around gardens being sprayed might get sprayed themselves. They could get sick. Animals might get sick when they eat weeds and grass containing pesticide residues.) There are

directions on all poisons that tell how the product should be used. The directions should be followed very carefully. Read the information on page 15 orally. Color.

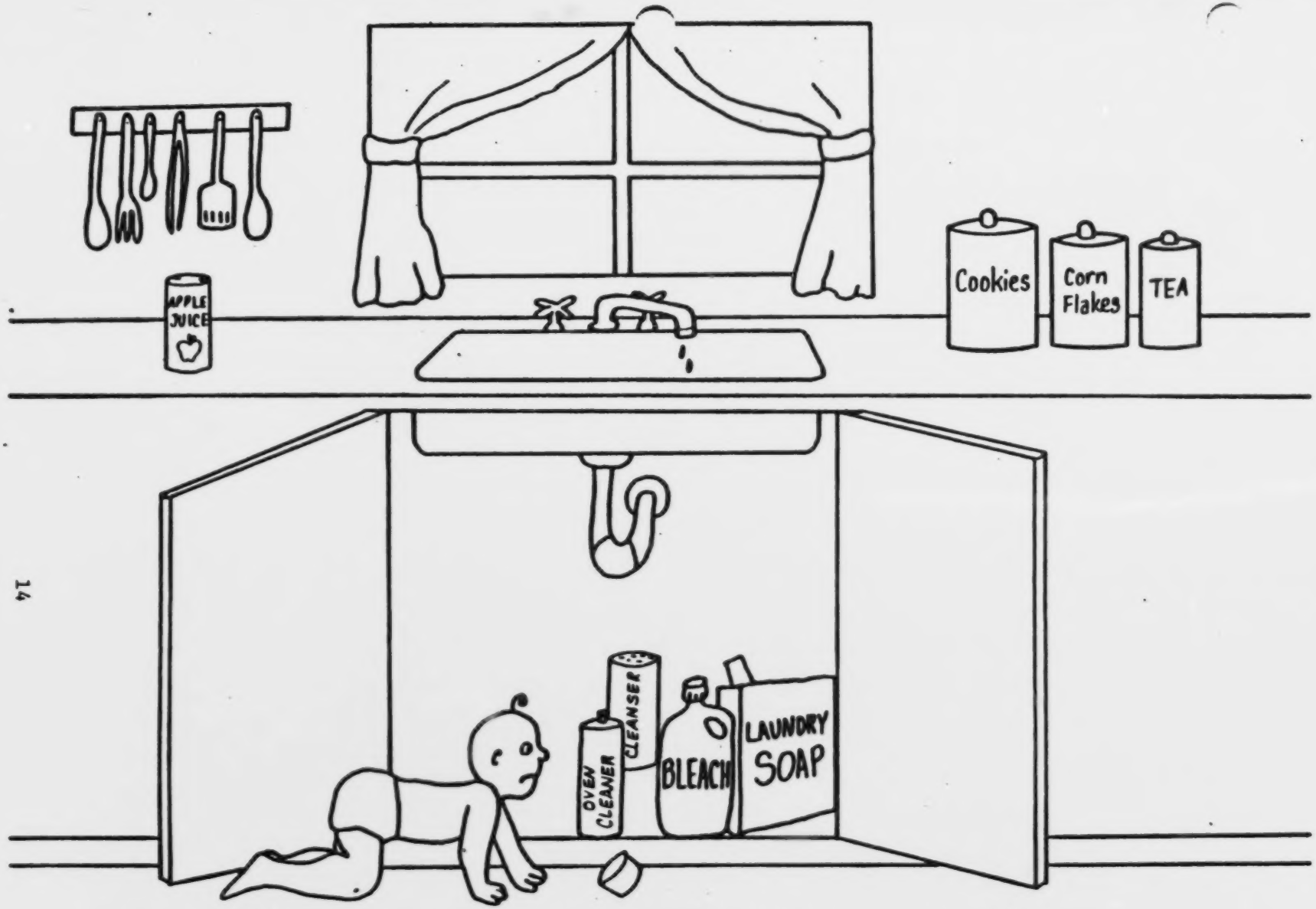
Page 16 - Similar to page 15. Snail killer is a poison. Discuss how snail killer can make people and pets sick. (EXAMPLES: Children and pets could get sick by eating the pellets.) Read the information on page 16 orally. Color.

Page 17 - Discuss how products kept in the bathroom are not safe to eat. (EXAMPLE: Some children think things are safe to eat and drink if they look pretty or smell good. Some poisons look pretty and smell good and could make us very sick if we eat or drink them. We should never eat or drink something unless we are sure of what it is.) Ask for suggestions on keeping bathroom supplies away from small children. Read the information on page 17 orally. Color.

ACTIVITY 2: Save pages and make a cover for the coloring book. On a large sheet of manila or construction paper, students can design individual covers. 8 1/2" x 11" plain paper can also be used. Have the children pick a theme for the cover. For example, "Safety in the Home."

EVALUATION: Discuss completed coloring books. Through oral questions, determine if the children understand the message on each page.

Direct the students to take the coloring books home and read the books with their parents.



Put an X on household products the baby should not eat.
Lock cupboards. Keep children away from dangerous products.

28

Weed poison is dangerous. Stay away from poisoned areas.
Put an X on the weed killer.

29

Snail killer is poison. Put an X on the box of snail killer.
Keep poisons away from children and pets.

Keep all bathroom products out of the reach of children.
Put an X on the products that the baby can reach.

HAZARDOUS AND TOXIC MATERIALS

TEACHING ACTIVITIES

GRADES 4-6

IT'S HARD TO CHOOSE

PURPOSE: To identify common sources of potentially hazardous wastes and alternatives to their use.

LEVEL: 4-6

FOCUS: General Aspects

SUBJECT: Science

CONCEPTS: In many cases, alternative procedures or substitute materials may be used to avoid problems inherent in the use and/or disposal of hazardous and toxic substances.

Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Assaff, Edith. Hazardous Wastes: The Consumer Connection. Kalamazoo: Western Michigan University, 1984, pp. 9-10.

BACKGROUND: Which is better: a plastic bag or a paper bag? It is difficult to decide. Both are the result of chemical-intensive production processes. In addition, new chemicals are constantly being developed to improve product quality and reduce cost.

Whether or not hazardous wastes are released into the environment depends upon how new the manufacturing plant is, how efficiently and conscientiously it is run, and the type of process used to make the product.

When we consider that this example deals with only two of the thousands of such products used in our daily lives, it becomes clear how closely our purchases contribute to America's waste problem. As Pogo once said, "We have met the enemy, and he is us."

The choice of one product over another is often not enough. There are, however, some questions we can ask ourselves before we buy any product in order to help us make our decisions.

Do I really need this product at all?

"Beware of all enterprises that require new clothes," Henry David Thoreau once warned. Any new purchase might be eyed with similar suspicion. Americans tend to be compulsive consumers, intent on possessing what Mark Twain referred to as, "all the modern inconveniences." It is amazing how many

goods we can say "no" to without affecting our comfort, health, or enjoyment of life. Each person makes these decisions based on their own priorities. However, asking yourself "do I really need this?" before you buy will not only help you to order your own priorities, but also to carefully and critically examine those priorities.

Should I substitute another product for this one?

If most products generate hazardous wastes, perhaps we should consider buying those which last longer, so that less waste will be produced. Cotton or jute shopping bags, for example, last much longer than plastic or paper. Since one out of every four pounds of plastic sold in the United States goes to packaging, buying goods that are less heavily packaged and buying food in bulk quantities can reduce the amount of plastic discarded. Reusable cloth towels, cleaning rags, handkerchiefs, and napkins can be substituted for disposable products.

Can I use less of this product, or use it less frequently?

Since most products involve at least some hazardous waste generation, the answer may not be in purchasing one product over another but in simply consuming less of everything.

If the label says to use one cup of laundry detergent, will two-thirds of a cup do the job? If the package says to spread lawn fertilizer three times a season, will once or twice be sufficient?

How will I use this product?

What happens to this product when we bring it home? Do we waste a great deal of it, or do we reuse it? If we need only a small amount and have no future use for the rest, do we throw it away or find a friend or neighbor to share it with? Do we pass along books, magazines, and catalogues to friends or public institutions?

"Waste is worse than loss," Thomas Edison tells us.

Where will this product ultimately end up?

...In a landfill? In the groundwater? Considering the ultimate disposal of a product can help us decide which type to use. If de-icing salt will eventually leach into the groundwater, can we use ashes or sand on our driveways instead?

Will we recycle this product, or just toss it out and buy more when it's gone? This question, too, can affect our choice.

Paper bags, plates and cups, for example, are biodegradable but not usually reusable -- while the same products made of plastic are usually reusable but not biodegradable. Most urban centers have recycling drop-off points for glass, metal, paper, and motor oil.

ACTIVITY: Use the above questions as a starting point to investigate the tradeoffs between use of brown bags or plastic bags; extend it by making comparisons between, for example, paper plates and plastic plates, and other common items. Students might work in teams to make such comparisons between pairs of items. The question, "What if we elect to use neither?" should be considered in all cases.

POPULATION GROWTH AND LIFESTYLES

PURPOSE: To recognize that increases in population size and lifestyle mannerisms affect the amount of waste generated.

LEVEL: 4-6

FOCUS: Social/Political Aspects

SUBJECTS: Science
Social Studies

CONCEPT: Increasing human population, higher standards of living, and resultant demands for greater industrial production promote increasing environmental contamination.

REFERENCE: United States Environmental Protection Agency. Let's Recycle! Washington, D.C.: EPA, 1980, p. 9. ED 188 919.

ACTIVITY: Draw a square on the floor with chalk, approximately five feet by five feet. This square can also be delineated by grouping chairs to form perimeters. Ask one child to step inside the square holding one piece of solid waste, probably scrap paper. Emphasize that each person involved cannot step outside the square once he or she is in it.

Then ask another to step in, assume they then have two children, those two marry and have two children, etc. The number will grow very quickly, yet the square remains constant. Ask the students how they would be able to get anyone out of the square. As the square grows more crowded, obvious reactions will be observed, especially pushing, restlessness, and general aggressive behavior.

Ask all the students to return to their seats, having first dropped their pieces of solid waste in the square. The result they will see will certainly be solid waste pollution. This graphically brings home the concept of more people, more waste, that our crowded cities have limited space, and that the amount of waste pollution increases every year.

WHERE DO THEY COME FROM?

PURPOSE: To identify the sources of solid waste and the problems associated with production levels.

LEVEL: 4-6

FOCUS: Social/Political Aspects

SUBJECTS: Mathematics
Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Biglan, Barbara. Solid Waste: Trash or Treasure? Pittsburgh, PA: University of Pittsburgh, 1979, pp. 7-8. ED 184 864.

BACKGROUND:

1. The first part of this activity (page 26) focuses students' attention on the fact that we all produce garbage or solid waste. (Technically, solid waste includes both garbage or refuse and sewage.) The left-over milk in the breakfast cereal bowl enters the sewage system; the empty cereal box awaits weekly pickup. In classrooms, the circular file or garbage can gathers paper and apple cores, among other things. (If you are certain nothing "filthy" or "slimy" will emerge from your room's trash can, you might have students empty it onto old newspapers and make a list of its contents.) After students have completed Activity 1, a class garbage list might be written on the chalkboard. (Later, students can organize their garbage list using the categories presented in Activity 2 and/or determine how to best dispose of each type of trash.)

2. The circle graph (Activity 2) shows where our nation's solid wastes come from. The amount of "home" or municipal garbage is relatively small while mineral waste is largest. (This suggests yet another side to energy issues.)

3. From the line graph (Activity 3) it can be seen that solid waste production has escalated dramatically since the mid-1940's. Discussion of these data might include consideration of questions such as:

   a. How have our ways of living changed in the past 30-40 years (since World War II)? (For example, more throw-away products and packages, greater energy use; also, wooden and metal toys were more often repaired than

thrown away, compared to today's plastic ones. In addition, there are more people using more products.)

b. Why might people be more concerned about solid wastes today than they used to be? (For example, more people producing more wastes living closer together in cities; greater concern with environmental quality.)

In order to obtain additional information (to verify their hypotheses), students might interview an older neighbor or relative, or they might consult library references.

ACTIVITY 1: Solid Wastes: Where Do They Come From?

From the moment you were born, you have been a S. W. P. (Solid Waste Producer). When your baby clothes were washed, detergent suds were left. When you didn't finish your cereal, solid waste was produced. It has been estimated by the U.S. Environmental Protection Agency that each of us produces 7.4 pounds of solid waste (garbage and sewage) per day.

Let's check on the solid wastes you produced yesterday (or any typical day). Starting with the time you got up in the morning, make a list of everything you threw out. Also try to remember everytime you turned on a water faucet -- the water going down the drain enters a sewage treatment facility. Try to think of at least 10 things. (Do NOT throw out this paper!)

1. _____ 7. _____

2. _____ 8. _____

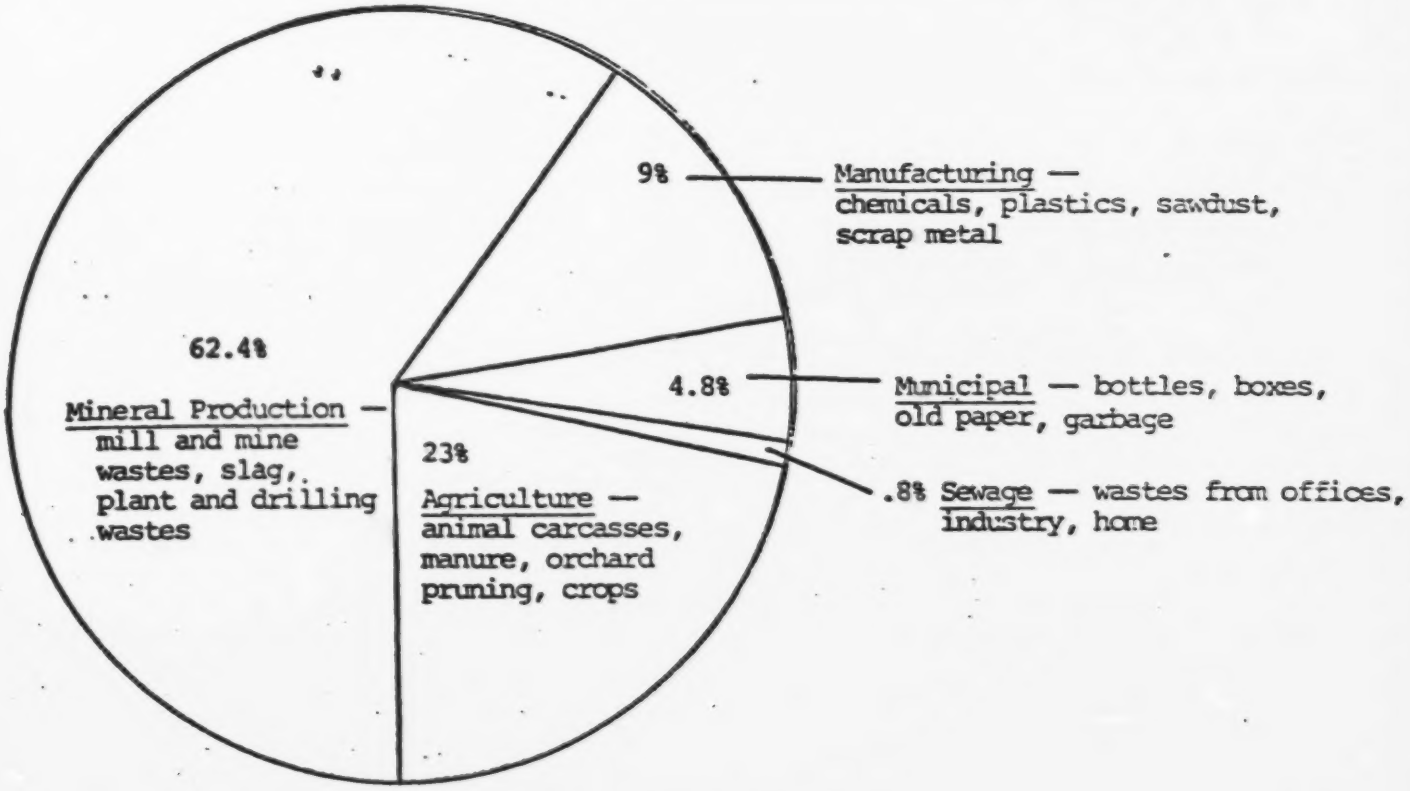
3. _____ 9. _____

4. _____ 10. _____

5. _____ 11. _____

6. _____ 12. _____

ACTIVITY 2: Sources of Solid Waste (1978)


9%
Manufacturing — chemicals, plastics, sawdust, scrap metal
62.4%
Mineral Production — mill and mine wastes, slag, plant and drilling wastes
4.8%
Municipal — bottles, boxes, old paper, garbage
23%
Agriculture — animal carcasses, manure, orchard pruning, crops
.8% Sewage — wastes from offices, industry, home

1. What is the largest source of solid waste?

_____

2. Which produces more solid waste, agriculture or manufacturing?

_____

3. To which source of solid waste do you contribute most?

_____

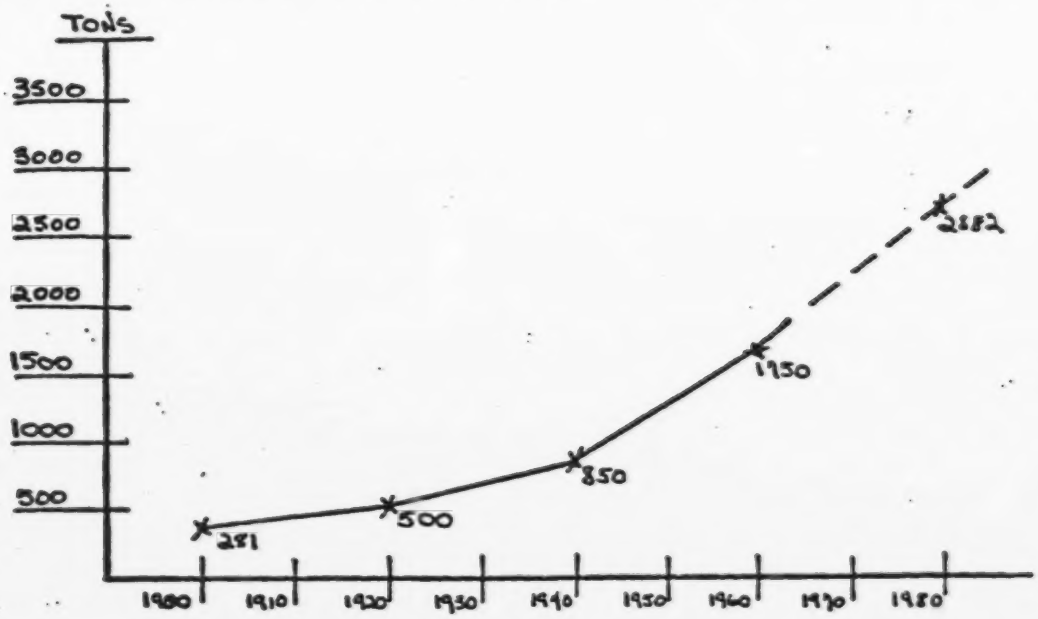
4. We need coal, oil and natural gas for energy. Coal mining produces waste material. To which source of solid waste does coal mining contribute?

_____

5. To which source of solid waste does drilling for gas and oil contribute?

_____

ACTIVITY 3: Solid Wastes Produced in the United States



1. From 1900 to 1920, what was the increase in tons of solid waste?

_____

2. From 1940 to 1960, what was the increase in tons of solid waste?

_____

3. From 1960 to 1980, there will be an estimated increase of 1250 tons of solid waste. During which 20 year period is the increase in solid waste greatest?

_____ 1900 to 1920; _____ 1940 to 1960; _____ 1960 to 1980?

4. What is different about the products you use today and the ones your parents used 10 or more years ago?

_____

_____

5. What might be some of the causes of the rapid growth in solid waste production?

_____

_____

HOW DO WE DISPOSE OF OUR WASTES?

PURPOSE: To become acquainted with the types of pollution that are caused by the disposal of solid wastes.

LEVEL: 4-6

FOCUS: Disposal of Hazardous Materials

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: United States Environmental Protection Agency. Let's Recycle! Washington, D.C.: EPA, 1980, p. 19. ED 188 919.

BACKGROUND DISCUSSION:

Q- What is meant by "throwing something away?"
Q- Where is away?
Q- How are waste products disposed of in our society? (Dumping, littering, burning, burying, recycling)
Q- How does our town dispose of its residential waste?

ACTIVITY: This activity should take place in a laboratory with the proper equipment such as goggles, bunsen burner, tongs, and a fume hood.

Proper Ventilation and Safety is stressed, especially for plastics.

Break the class into teams. Give each team 5 to 10 materials to burn. Prepare a data sheet or a chart for noting the initial weight and residue weight of each item burned, the color of flame and smoke, and the odors produced.

Burn a variety of household waste including food, metal, plastic, paper, etc.

Q- What are the components of the smoke? Could they be harmful?
Q- Could the smoke be filtered or cleaned to render it harmless to our environment?
Q- What are the advantages of burning our waste? (reduction in volume, breakdown of some dangerous chemicals, etc.) Could the heat generated be productively used?
Q- Does your community burn any of its waste? Does it use effective antipollution control equipment?

HOUSEHOLD TOXIC SUBSTANCES

PURPOSE: To develop an understanding that unsafe disposal of household toxic substances may have harmful effects on health and on the environment.

LEVEL: 4-6

FOCUS: Health Aspects; Disposal of Hazardous Materials

SUBJECTS: Science
Health

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 4-6. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 27-43. ED 266 949.

ACTIVITY:

1. Pass out "Routes to the Environment I and II" sheets (pages 33-35) to each student. Introduce the various methods of household toxic disposal:

   a. Dumping toxics in the trash.
   b. Washing toxics down the drain.
   c. Throwing toxics on the land.
   d. Incinerating toxics.
   e. Recycling waste motor oil. (Not available in all communities nationally.)

   To facilitate discussion, pass out a copy of page 35. Discuss the various options given.

2. Using the sheets from pages 33-34 have each student visually trace each method of disposal. Each student may trace these methods with colored pencils/crayons to color code each disposal route.

3. As these routes are being established visually, have the students pay attention to where products go after leaving the house. For example, when something is thrown down a sink drain (page 33), it goes to a septic tank or treatment plant and then into a waterway. Discuss the possible damaging effects each method can have on the environment or health. The following are examples:

a. Trash goes to landfills/dumps. Refuse workers have been injured when collecting trash containing toxic chemicals. Workers at the landfill can also be injured.

b. Substances dumped in household toilets or drains (e.g., sinks and tubs) go directly into the sewers or septic tanks. The sewer systems may lead to rivers or sewage treatment plants. The sewage treatment plants, as well as septic tanks, are not designed to handle many hazardous wastes. Also large amounts of hazardous wastes may kill the living organisms in the treatment plant and septic tanks. These living organisms feed off the conventional waste (bacteria, fecal matter, etc.), thereby treating it before it is discharged to a body of water or on land. If the organisms are killed, both hazardous wastes and conventional pollutants can enter our waterways.

c. Wastes dumped in storm drains may lead directly to local waterways.

d. Wastes dumped on weeds or in holes in the ground could leach into the soil, eventually contaminating ground water.

e. Burning toxic waste can pollute the air which we breathe. It is extremely dangerous to burn products in aerosol cans. The cans explode under pressure creating a virtual timebomb.

4. Ask the class if they could think of any safe disposal methods for household toxic substances. Allow time for responses. Some responses might include "Make sure the product is all used up before throwing it in the trash"; "Maybe a neighbor could use it." If students suggest this latter remark, be sure students realize that it may not always be wise to give away all types of potentially toxic products. If some toxics are given to people who don't handle them responsibly, the toxics can damage people or hurt our environment. For instance, some pesticides are highly toxic and giving them to a neighbor who doesn't use them according to the instructions may result in undesirable consequences. Injuries or illness may occur from the person using the product openly around children or pets, not wearing the recommended protective clothing, using the product for other than its intended purpose, or overusing the product. If "recycling" of waste oil is not mentioned, suggest it. In some states, service stations will accept waste oil from the public, free of charge. The stations then sell the oil, in large amounts, to an oil recycler. California, Oregon, Nevada, Washington, New

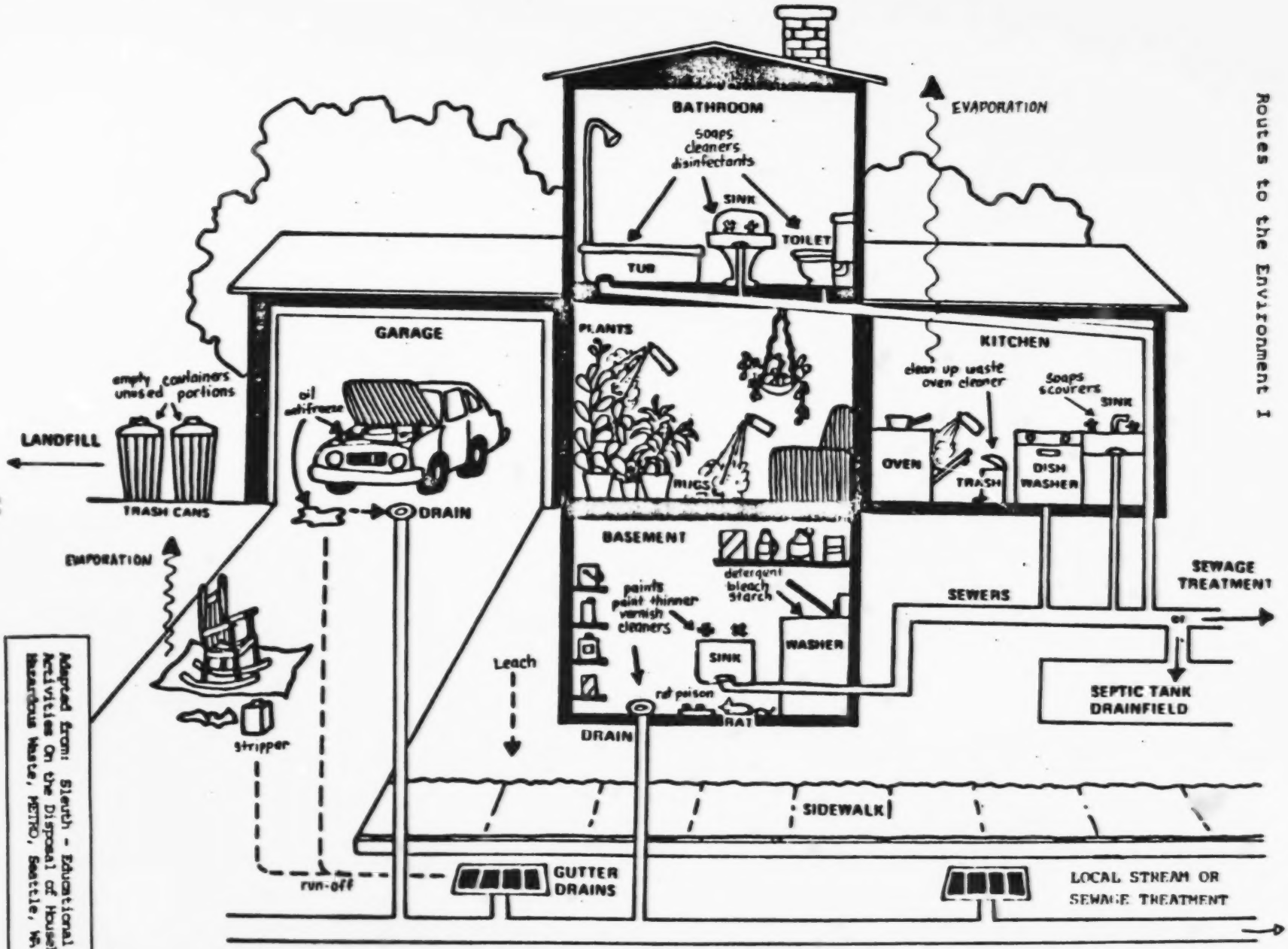
Jersey, Maryland, Arkansas, Ohio, Michigan and Alabama have recycling programs as of this printing. To find out about recycling programs in your area, you can call the Association of Government Oil Recycling Officials (AGORO). The East Coast contact person and telephone number is (301) 269-3355, Hilary Tatem. The West Coast contact person and telephone number is (916) 322-1443, Guenther Moskat (also with the California Waste Management Board). California residents can also call the California Waste Management Board's toll free number for recycling information, (800) 952-5545.

Recently, some local governments and community organizations have become interested in developing safe disposal systems for residentially generated hazardous wastes. Some cities and counties in the country have set up collection systems for household toxics. When the toxics have been collected from the public (generally at a pre-designated collection site on a given day or days), they are ultimately disposed in a facility designed to dispose of hazardous wastes. This relatively new disposal concept is taking root in jurisdictions across the nation.

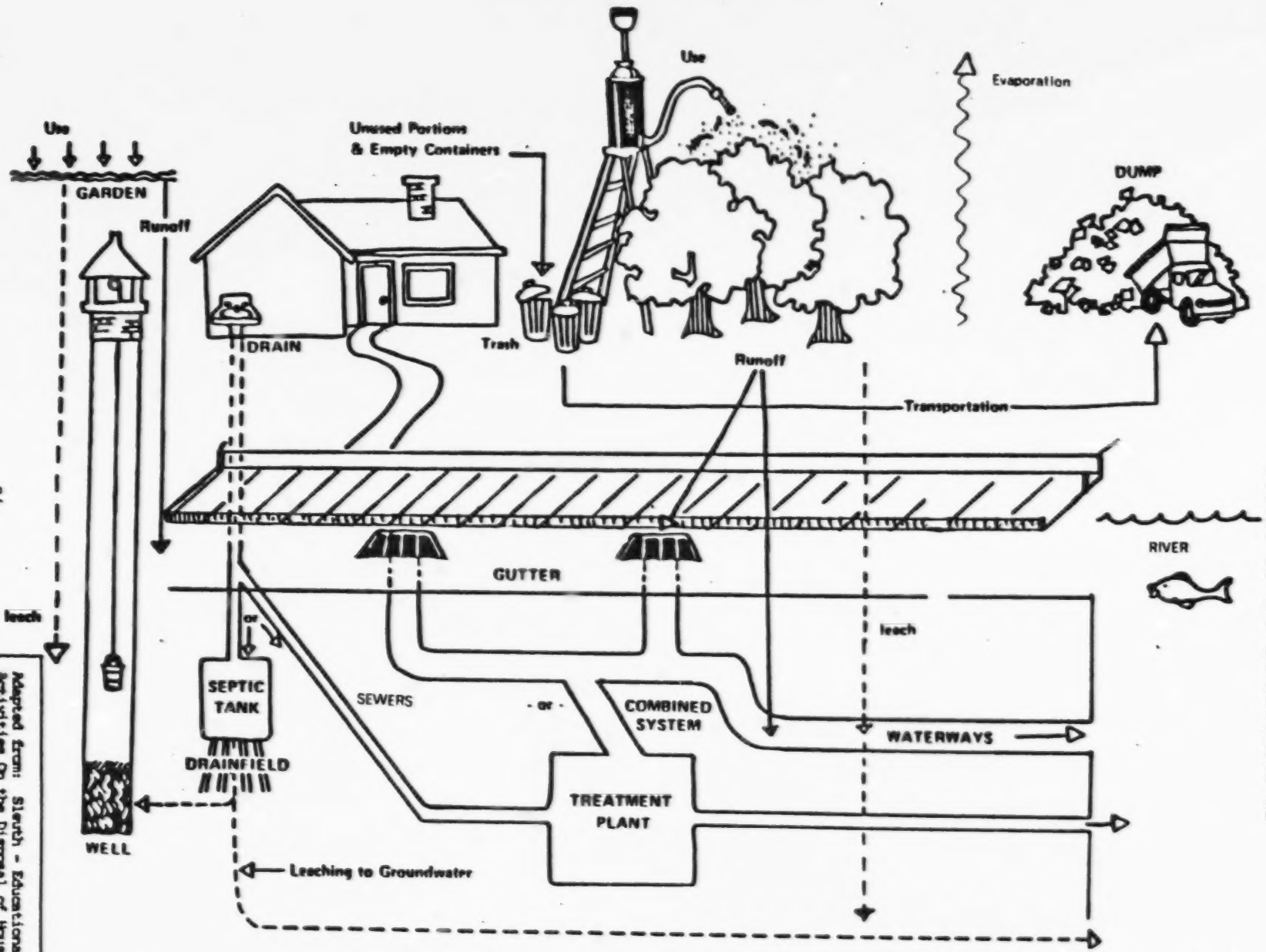
5. Inform students that currently there are few alternatives for safe and economic disposal of household toxic substances. Contacting the local County Environmental Health Department, the City/County Water Quality Divisions, the State (Solid) Waste Management Board, the State Department of Health Services, City Council, or County Boards of Supervisors would be some ways of finding out what is currently being done in your community. People called hazardous waste haulers will take your toxics to a special disposal facility designed to accept hazardous waste; however, the service is generally very costly.

6. Ask the students this: If safe and economic methods of toxic disposal are not available to all communities, how can we handle the problem of safe disposal? Allow discussion time.

7. Conclude that we must be careful about what and how much potentially toxic substances we buy. We should try to use all that we buy to avoid having to dispose of toxic substances. We also could consider buying products that are less toxic than others.



Adapted from: Sleuth - Educational Activities On the Disposal of Household Hazardous Waste, METRO, Seattle, WA



Adapted from: Sleuth - Educational Activities On the Disposal of Household Hazardous Waste, METRO, Seattle, WA

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Routes to the Environment II

Adapted from: Sleuth - Educational Activities On the Disposal of Household Hazardous Waste, METRO, Seattle, WA

Adapted from: Sleuth - Educational Activities on the Disposal of Household Hazardous Waste, METRO, Seattle, WA

HEALTH EFFECTS OF AIR POLLUTION

PURPOSE: To investigate the dangers associated with air pollution to the human body.

LEVEL: 4-6

FOCUS: Hazardous Materials in the Air

SUBJECTS: Health
Science

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Alaska Department of Environmental Conservation. Clean Air for Anchorage and Fairbanks, Curriculum for Grades 1-6. Juneau: South East Regional Resource Center, February 1980, pp. 14-15. ED 212 460.

ACTIVITY: Discuss with students the health effects of carbon monoxide. In large amounts it can kill, while smaller amounts can cause dizziness and headaches. Also discuss the concept of particulates, including dust and smoke.

Investigate the dangers of lung disease, caused by particulates and poisonous gases in the air.

On a diagram of the human body, indicate the portions of the body--brain, lungs, etc.--affected by various air pollutants. Provide information as to the sources of these air pollutants.

Invite a health worker, a doctor, or a pollution control specialist to speak to the class concerning the adverse health effects of air pollution.

SUBSTITUTES AND ALTERNATIVES

PURPOSE: To identify safe substitutes and alternatives for household toxics.

LEVEL: 4-6

FOCUS: Health Aspects

SUBJECTS: Health
Home Economics

CONCEPT: In many cases, alternative procedures or substitute materials may be used to avoid problems inherent in the use and/or disposal of hazardous and toxic substances.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 4-6. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 44-50. ED 266 949.

ACTIVITY:

1. Introduce the lesson by asking students to name some potentially toxic products used in their homes to: a) clean and freshen the house; and b) take care of the yard and garden. List their responses on the board under the "a" and "b" categories identified above. Add some of your own.

2. Display advertisements/pictures of household toxics. Have the students observe the packaging and slogans used by each company to sell their product. Ask the students to recall any advertisements they have seen on TV. What was the slogan, jingle or gimmick used to sell that particular product? Why might a consumer buy these toxic products? Discuss.

3. Explain to the students that many potentially toxic products that we purchase are not always necessary, and are sometimes expensive. There are safer substitutes for some of these products available at most grocery stores.

4. Ask students if they can think of alternatives for any of the products listed on the board. Write their answers next to the corresponding toxic.

5. Explain that "simplicity is the key." Four or five safe products can usually take the place of many other household toxics. OPTIONAL: Show samples of safer substitutes and give examples of their uses.

6. Hand out the "Safer Alternatives..." sheets on pages 41-42 to each child. Read through substitutes with the class. Discuss:

- Can students think of additional substitutes for the categories mentioned?

- Are any of these surprising?

- Can these substitutes be purchased easily? Where?

- Are any of these substitutes used in their homes already?

- Do they think their family would be willing to try an alternative? If "no," why not? (e.g., not as efficient?)

Prices of products--How do the safer substitutes compare in price to convenience products? Refer to the price list that you have developed prior to introducing this lesson. How can convenience products be made (e.g., vinegar and water used to wash windows can be kept in a pump spray).

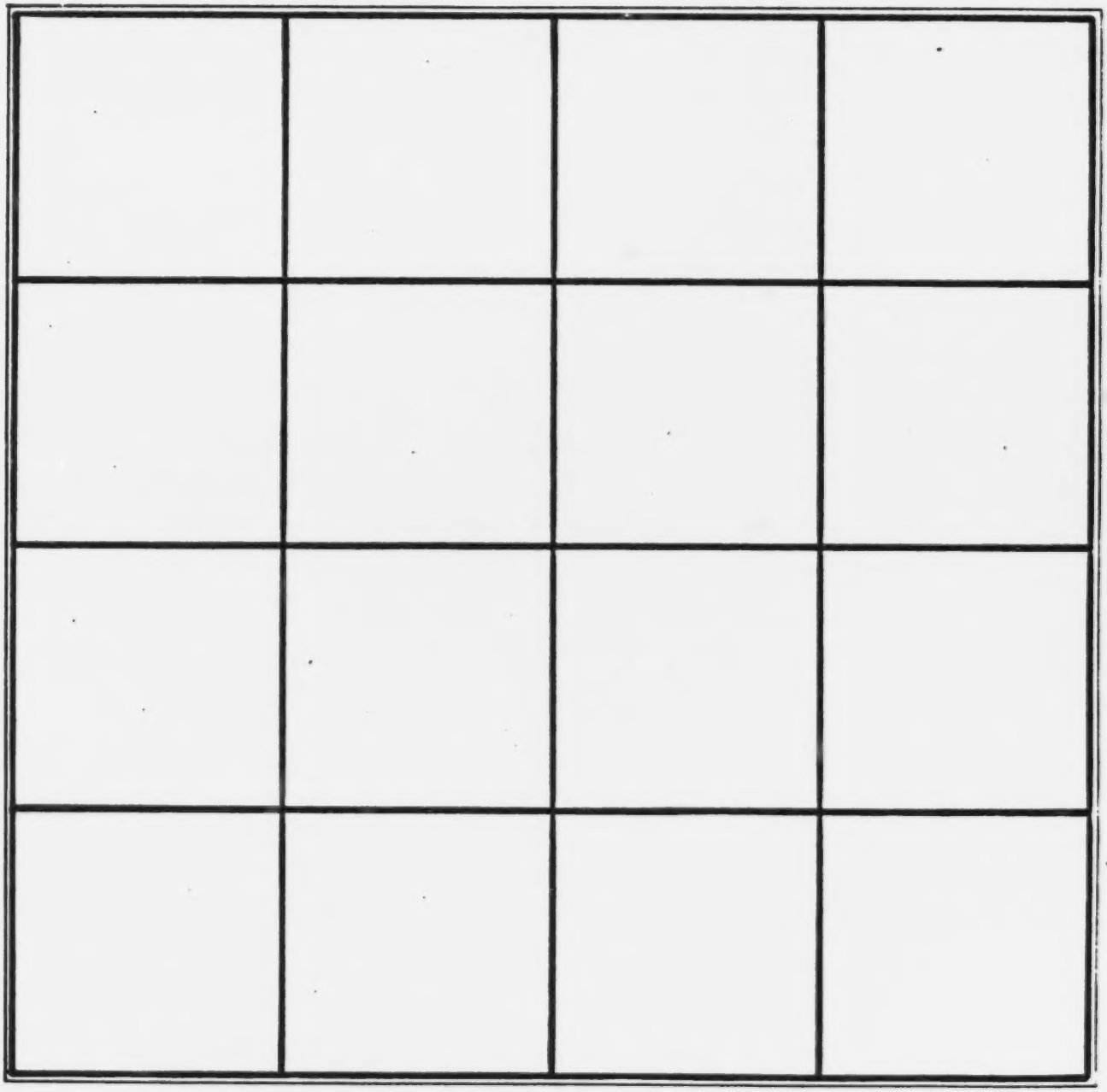
7. Tell the students that they are going to play a game called TOXIC FREE BINGO. Pass out a blank grid to each student (page 39). Each student will fill in their own grid by randomly writing a toxic product (the underlined headings on pages 41-42) into each square of their grid. No word or phrase may be used more than once.

8. Explain that you will draw a card from the box that will have a safe substitute written on it (Master Cards are given on page 40). You will read this out loud and the students will look for the toxic product on their card that can be replaced by this particular substitute. Example: teacher calls "baking soda." Student may place a marker on oven cleaner, deodorizer or scouring powder. Student must only choose one! They may refer to their information sheet on "Safer Alternatives for Toxic Products," pages 41-42, for help.

   The object is to get 4 in a row; up and down, side to side, or diagonally. Four corners also count as a "win."

   When you finish one game, students may switch cards and play additional games. Keep cards for future use.

TOXIC FREE BINGO



MASTER CARDS

Cut each Rectangle and place in a container.

soap and water	pan with beer
lemon juice and vegetable oil	mayonnaise and soft cloth
pump-type sprayers	plunger
open windows for fresh air	plumber's snake
hot vinegar set in a dish	water based paint
baking soda	overturn clay pots
fresh cut flowers	compost
dried flower petals mixed with spices	screens
washing soda	cream of tartar
grated lemon rind	biodegradable soap
steel wool	vinegar and salt
mechanical mouse traps	brewers yeast
eucalyptus leaves	salt on spills

SAFER ALTERNATIVES FOR TOXIC PRODUCTS

The following is a list of safer substitutes for some household toxics. Generally, the products can be bought in grocery stores.

Aerosol Sprays

- o Use pump-type sprays whenever possible to replace aerosols (e.g., hair sprays).
- o Use fresh flowers or sachets of dried petals mixed with spices instead of room sprays.

Ant Control

- o Sprinkle cream of tartar in front of ant's path. Ants will not cross over. Cream of tartar is a substance used in baking.

Bug Spray

- o Place screens on windows and doors.
- o Brewers yeast tablets taken daily give the skin a scent that mosquitos seem to avoid.

Chemical Fertilizers

- o Compost.

Copper Cleaner

- o Pour vinegar and salt over copper and rub.

Deodorizers/Air Fresheners

- o Open windows or use exhaust fans as a natural air freshener.
- o A dish of hot vinegar can get rid of fish odors.
- o Baking soda placed in the refrigerator reduces odors.
- o Fresh cut flowers or dried flower petals and spices can add a nice scent to a room. You can also boil potpourri or cinnamon and cloves in water to produce a nice scent.

Detergents (Laundry & Dishwashing)

- o Replace detergents with soaps that are relatively "non-toxic" and biodegradable. (To wash out residue from detergents, prewash in washing soda.)

Drain Openers

- o Pour boiling water down the drain. Do this every week for preventive maintenance.
- o Use a plumber's helper (plunger) or a plumber's snake.

Flea Repellant

- o Place eucalyptus seeds and leaves around the area where the animal sleeps.

Floor Cleaners

- o Use soap and water.
- o Use washing soda and water.

Furniture Polish

- o Use a soft cloth and mayonnaise.
- o Mix 1 part lemon juice and 2 parts vegetable oil.

General Cleaners (All Purpose Cleaner)

- o Mix 3 TBSP. washing soda in one quart of warm water.
- o Use baking soda with a small amount of water.

Glass and Window Cleaners

- o Use cornstarch and water.
- o Mix 1/2 cup vinegar and one quart warm water. Wipe with newspapers.
- o Use lemon juice and dry with a soft cloth.

Oven Cleaners

- o Mix 3 TBSP. of washing soda with one quart of warm water.
- o Place liners in oven to catch any drips during baking.
- o Sprinkle salt on spills when they are warm and then scrub.
- o Rub spills gently with steel wool.

Paint

- o Water based paints are less toxic than metal based. After using them, no solvent is necessary for "clean up."

Rat Poison

- o Put a screen over drains.
- o Use mechanical-snap mouse traps.

Scouring Powder

- o Dip a damp cloth in baking soda and rub.
- o Use steel wool.

Snail/Slug Bait

- o Place a shallow pan with beer in the infested area.
- o Overturn claypots. The snails will take shelter in them during the sunny days and they can be collected and removed.

TESTING FOR LEAD

PURPOSE: To test for the presence of lead in auto exhaust, and discuss its impacts on the environment.

LEVEL: 4-6

FOCUS: Hazardous Materials in the Air

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: McDermott, Hugh, and Larry Scharmann, editors. Fueling Around--Hazardous to Your Health. Lincoln: Nebraska State Energy Office, February 1981, pp. 35-36. ED 222 364.

BACKGROUND: Much of the lead in the air comes from the compounds used in anti-knock agents in gasoline: tetraethyl lead and tetramethyl lead. About 70-80 per cent of it is exhausted into the atmosphere in the form of small particles of lead compounds. Of the remaining 20-30 per cent, about half is scavenged into the lubricating oil and half is retained in the engine and exhaust system. Lead compounds are poisonous, but it is not known precisely how damaging the lead particles from the automobile are to the environment. Lead is, however, a cumulative poison and even small amounts continuously present in drinking water could lead to death.

ACTIVITY: This activity must be conducted as a teacher demonstration, outdoors.

Students should choose several cars, some using regular and some using unleaded gasoline. Collect the emissions from each exhaust pipe in a large plastic garbage bag. CAUTION: The pipe may be hot; use of gloves is strongly recommended.

Insert rubber tubing into the bag, running it through a bowl of ice and salt to trap moisture. Bubble the fumes into a beaker containing a solution of concentrated acetic acid and chromic anhydride; observe the results.

Compare the results obtained from tests with regular and unleaded gasoline.

MAKING ACID RAIN

PURPOSE: To determine the factors responsible for influencing acidity levels of water.

LEVEL: 4-6

FOCUS: Hazardous Materials in the Air; Hazardous Materials in the Water.

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Taylor, Carla, editor. Groundwater: A Vital Resource, Student Activities. Knoxville: Tennessee Valley Authority, September 1985, pp. 40-41. ED 262 970.

BACKGROUND: Acid rain is a very real problem in much of the United States. Gaseous pollutants (such as nitrogen oxide and sulfur oxide from auto and factory emissions) in the air dissolve in rain as it falls. The resulting acid rain affects not only the plant life on earth but raises the acid level in lakes and in streams where it can prove hazardous to the water life.

ACTIVITY:

1. Add drops of bromothymol blue to 5 ml of water in a test tube until the water becomes light blue. Explain to the participants that in the presence of an acid the bromothymol solution will turn yellow.

2. Set a small candle in a glass jar. Light the candle and place a glass plate over the jar. (Review with the participants that a candle gives off the gas carbon dioxide.)

3. After the candle goes out, add the bromothymol blue solution in the test tube to the jar. Replace the glass cover and shake the jar vigorously.

4. Observe what happens.

DISCUSSION: Participants should observe that the water turns yellow. Explain that other gases in the air also dissolve in the water, changing the water to an acid as the carbon dioxide did. Explain to the class that nitrogen oxides and sulfur oxides are two gases found in the air that produce acid rain. Then review these questions:

1. What gas caused the water to turn to acid?

2. Name two other gases that make water acid when they dissolve.

HAZARDOUS METALS

PURPOSE: To investigate how acid rain can cause the release of hazardous metals into the environment.

LEVEL: 4-6

FOCUS: Hazardous Materials in the Air; Hazardous Materials in the Water.

SUBJECT: Science

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Minnesota Sea Grant Program. Aquatic Activities for Middle School Children: A Focus on the Effects of Acid Precipitation. Minneapolis: University of Minnesota, 1982, pp. 61-62. ED 223 436.

BACKGROUND: Besides the direct damage that acid rain does to organisms, the acid when dissolved in water also has the property of dissolving metals which had been previously in the sediment at the bottom on water bodies. Toxic materials such as aluminum, zinc, and mercury get into the water and from there into aquatic organisms. The toxicity of many metals depends upon how much of the metal is present. Zinc, for example, is an important nutrient in small quantities, but when too much is present it becomes poisonous.

ACTIVITY: Fill two containers with one inch of vinegar. Into one container place a galvanized nail, such as a nail used for fastening shingles. Leave both containers for 24 hours.

After 24 hours, put a couple of drops from each container on a glass slide or mirror. Note any differences in the appearance of the liquid. Speculate as to the cause of any differences noted.

NOTE: In place of a galvanized nail, a lead sinker or steel wool may be used.

SICK AIR?

PURPOSE: To identify the hazardous products of combustion.

LEVEL: 4-6

FOCUS: Hazardous Materials in the Air

SUBJECT: Science

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Bonar, John, editor. Probing the Natural World, Level III Teacher's Edition: Intermediate Science Curriculum Study. Tallahassee: Florida State University, 1972, pp. 59-62. ED 190 361.

BACKGROUND: Air pollution, along with water pollution, is a major problem for our nation. Factories steadily belching smoke, trash dumps endlessly smoldering, and backyard incinerators burning intermittently have added millions of tons of waste materials to the atmosphere. What are these wastes like? And what effects do they have on the environment? To start finding out, you and a partner will need about 30 minutes and the following materials:

1 book of safety matches
1 600-ml beaker or large jar
1 small lid (from a baby food jar)
2 small wads of cotton
1 small piece of wool cloth
1 small piece of Styrofoam
2 sheets of notebook paper, each cut in half
1 dropper bottle of turpentine (as needed)

ACTIVITY 1: Place a small wad of cotton in the center of the lid. Place the lid on a clean half sheet of notebook paper. Label the paper "Cotton." Light the cotton and invert the 600-ml beaker or jar over the lid.

ACTIVITY 2: If the flame begins to die before the cotton is burned, lift the beaker slightly to let more air into the beaker. Then replace the beaker on the paper. Observe the beaker and its contents for two minutes after the flame goes out. Record all your observations in Table 1 in your Record Book.

Arrange for ventilation during the burning activities. Open windows, provide a fan to blow the smoke out, or use a fume hood if available. You may want to have the activity done outside.

When describing the products of burning, include the following: kinds of products; color; odor; whether it is a solid, liquid or gas; and the appearance of whatever remains on the paper and lid after each burning. Be sure each piece of paper is labeled. Clean the lid and beaker after each burning and before doing the next part of the activity.

ACTIVITY 3: Put two drops of turpentine on a fresh wad of cotton. Label a clean half sheet of paper "Turpentine." Then repeat the procedure in Activities 1 and 2.

You may have to monitor the use of turpentine and Styrofoam. Some students enjoy watching the black soot form, and will want to use more than two drops of turpentine or a small piece (1 cm square) of Styrofoam.

Use the same general procedure for the wool cloth and the Styrofoam. Be sure to label and save each paper for comparison.

TABLE 1

Material Burned	Color and Odor of Smoke Produced	Description of Other Products of Burning	Other Observations
Cotton			
Turpentine and cotton			
Wool cloth			
Styrofoam			

If you want to determine the effects of burning samples of some other substances, be sure to get your teacher's permission first. You may then enlarge Table 1 and add your findings.

1. On the basis of your observations, which materials do you think would produce the most air pollution when burned?

Question 1 may seem easy at first. Deciding which substance produced the most smoke and the most unpleasant odor is not difficult. However, you may not be able to tell by looking and smelling whether or not harmful gases are being produced by some of the substances.

2. Which of the materials when burned produced the poisonous gas carbon monoxide?

   You cannot, just by looking, tell what gases are produced from burning, except possibly for one. Yet even when something burns without producing black smoke, or any smoke at all, products are released. Of course, not all products are harmful.

   You probably noticed that a liquid formed on the inside of the beaker when one or more of the substances were burned.

3. What gas, produced during the burning, probably formed the liquid in the beaker?

   You may be able to guess that, in addition to water vapor, another gas was produced as each substance burned.

4. What gas product of most fires is used by plants in photosynthesis?

5. In doing this last activity, did you add to the pollution of the air?

   Americans place about 190 billion kilograms of waste materials into the air each year. Five sources account for most of the nationwide air pollution problem. Table 2 shows what these sources are and identifies some of the chemical wastes from each source.

6. What source produces the greatest amount by weight of air pollution?

7. What source produces the most carbon monoxide?

8. If one wanted to reduce the solid particulates in the air, which sources would he have to confront?

9. What are the two main sources of sulfur oxides?

   The information in Table 2 applies to the entire United States. There may be major differences in the sources of pollution products in a particular region.

10. Which types of air pollutants listed in Table 2 directly affect man's health?

Table 2

Source	POLLUTANTS (billions of kg) Carbon Monoxide	Hydro-carbons	Nitrogen Oxides	Sulfur Oxides	Solid Par-ticulates	Total by Source
Transportation (cars, trucks, buses, etc.)	58.1	15.9	6.9	0.3	1.1	82.3
Electrical power plants and heating	1.7	0.6	6.0	20.6	8.3	37.2
Industry	9.6	3.2	0.2	6.5	6.9	26.4
Refuse disposal	6.9	1.4	0.5	0.1	0.9	9.8
Misc. (forest fires, etc.)	15.2	7.4	1.6	0.6	8.7	33.5
Totals	91.5	28.5	15.2	28.1	25.9	189.2

POLLUTION--PONDS TO GROUNDWATER

PURPOSE: To demonstrate and explain how ponds and groundwater become polluted by oil, chemicals, and detergents.

LEVEL: 4-6

FOCUS: Hazardous Materials in the Water

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Taylor, Carla, editor. Groundwater: A Vital Resource, Student Activities. Knoxville: Tennessee Valley Authority, September 1985, pp. 56-57. ED 262 970.

BACKGROUND: There are many ways in which water becomes polluted. First, there is natural pollution. Soil, leaves, and tiny organisms get into water from nearby land. Then, there is pollution caused by people. In farm areas, fertilizers and insecticides get into streams and lakes. So does runoff from animal feed lots. In industrial areas, harmful wastes are dumped into the water from factories and refineries. In cities, sewage and runoff from trash dumps find their way into the water. This, in turn, seeps into the groundwater, which is where a number of cities and most rural areas get their drinking water. Pollution of water is a very serious problem.

ACTIVITY: Follow these steps to make your own polluted pond water and see what pollution can do to our groundwater. Record findings on the chart below on the chalkboard.

1. Label 2 jars each 1, 2, 3, and 4 with masking tape. Fill one set of jars (1-4), with lids, halfway with water.
2. Observe the water in jar 1. Describe it in the chart.
3. Put the oil in jar 2; tighten the lid and shake the jar. What did you observe? Record your findings on the chart.
4. Put the vinegar in jar 3; tighten the lid and shake the jar. What did you observe? Record your findings.
5. Put the detergent in jar 4; again tighten the lid and shake the jar. Record your findings.

HOW CLEAR IS THE SOLUTION?

Jar 1 _____

Jar 2 _____

Jar 3 _____

Jar 4 _____

The following steps will illustrate how the polluted pond water affects the groundwater.

6. Put soil in funnel and place funnel on empty jar 1.

7. Pour contents of jar 1 (water only) through funnel, let drip into glass. Fill out another chart like the first one, starting with jar 1, etc.

8. Move funnel with soil to empty jar 2. Pour contents of jar 2 (oil and water) into funnel. Observe and record.

9. Repeat steps with jar 3 (vinegar) and jar 4 (detergent). Observe and record.

10. Compare findings on each chart.

DISCUSSION:

1. If these elements were added to a real pond and seeped into the groundwater, how would it affect the water in the pond and the ground?

2. How would animals/people be affected?

3. Why did we use the same soil?

THE UNDESIRABLES

PURPOSE: To investigate the harmful effects of chemical contaminants on plant growth processes.

LEVEL: 4-6

FOCUS: Biological Aspects

SUBJECT: Science

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Bonar, John, editor. Probing the Natural World, Level III Teacher's Edition: Intermediate Science Curriculum Study. Tallahassee: Florida State University, 1972, pp. 31-36. ED 190 361.

BACKGROUND: You are very fortunate if you are the first human to use water during its most recent cycle on the earth. Most of us drink water that has already been used by one or more persons upstream. Of course, the used water is usually safe because it has passed through purification plants. However, as the earth's population increases, more and more water is used again and again during its journey to the sea. And it becomes exceedingly difficult to remove undesirable chemicals from water. In this chapter, you will investigate the effects of two substances that can be considered as undesirable--cleaning agents and pesticides. Normally useful to man, these substances are most undesirable in surface water.

Up until the 1930's, soaps were the principal cleaning agents for home and industry. Then detergents were developed. They rapidly became very popular because they had better sudsing properties than soap. Detergents were faster acting and longer lasting. And detergents did not leave the common "bathtub ring" so characteristic of soaps. Unfortunately, the good cleaning features of detergents turned out to be their poorest characteristics as far as surface water was concerned. As detergents from millions of kitchen and bathroom sinks and from thousands of factories and businesses were dumped into surface waters, suds began to collect in rivers, streams, and lakes. Because the detergents are so long-lasting, sudsy water even flowed from taps in some homes! Surely such contaminated water must affect living organisms. Perhaps you would like to see for yourself.

What do you predict will happen to seeds a farmer sows if the water he uses to "get them going" (germinate them) contains detergent wastes? Will the detergent affect the number of seedlings that germinate? Will it affect the seedling's growth?

In the following activities, you will try to answer these questions. You will investigate the effect of detergent on the germination and growth of seedlings. You and your partner will need about 15 minutes to set up the investigation. Completion of the experiment will take several days. Rather than wait for things to happen, you will be starting other activities as soon as you get this first one going. Get the following materials:

1 wax marking pencil
4 plastic petri dishes with lids
4 pieces of paper toweling cut to fit the bottom of the petri dishes
40 (approx.) radish seeds
10 ml of 1% detergent solution (already prepared)
10 ml of 5% detergent solution (already prepared)
Tape
Tap water

ACTIVITY 1: Be sure the petri dishes are clean. Then label them as shown, using a wax marking pencil. Using an ordinary pencil, put your initials on each piece of toweling and place one piece of towel in each dish.

Labels

C C 1% 5%

ACTIVITY 2: Pour 10 ml of tap water into each of the "control" dishes. Pour 10 ml of the 5% detergent solution into the dish marked "5%." (You are using two control dishes here because you will need them both later.) Put 10 ml of the 1% solution in the dish marked "1%."

ACTIVITY 3: Place ten radish seeds in each dish. Spread them out.

ACTIVITY 4: Cover each dish with a taped-on lid and put the dishes in a place provided by your teacher. Begin your observations of the seeds during your next class period, as indicated in Activity 6.

ACTIVITY 5: Do chemical changes occur in a seed as it germinates? For example, does it exchange gases with its environment? Here's how to find out. You will need the following materials:

2 doz. radish seeds
4 plastic vials with lids
2 ml methylene blue
8 ml tap water
2 ml phenol red

Put about a dozen radish seeds into a plastic vial. Add 2 ml of tap water and 1 ml of methylene blue indicator. Prepare a control by putting 2 ml of water and 1 ml of methylene blue indicator into another vial. Leave the seeds out of the second vial.

Repeat the same procedure with two more vials, but use phenol red indicator instead of methylene blue. (A change in color of phenol red to yellow can be used to indicate the presence of CO_2 gas.)

Note and record in your Record Book the initial appearance of each of the four vials. Set them aside in a designated place until tomorrow. Then record your observations again and provide a written explanation of the results. Your discussion should include answers to the following questions:

1. Do chemical changes occur in a seed as it germinates?
2. Do germinating radish seeds absorb, or release, CO_2?
3. Do germinating radish seeds absorb, or release, oxygen?

If 24 hours or more have passed since you did Activity 4, you are ready to go ahead with Activity 6 and to start Table 1. Be sure to record how many hours it has been since you put the seeds in the vials.

ACTIVITY 6: Look at the dishes with the radish seeds. Do not remove the covers. Record the percent germinated in the space provided in Table 1 of your Record Book. Five out of ten would be 50% germinated. (A seed has germinated if you can see part of a root poking out of it.) Don't throw the seedlings away! You'll observe them again.

Table 1

Day Observed	Hours Elapsed	DISH C (Control) % Germinated	1% Detergent Solution: % Germinated	5% Detergent Solution: % Germinated
1				
2				
3				

In Table 2 of your Record Book, describe the seedlings in each dish. Your description should answer questions such as these:

1. Are the roots, stems, and leaves visible or not?
2. Have the leaves unfolded?
3. Are the leaves yellowish, whitish, or green?
4. Are root hairs (tiny fuzzy growths) visible?

Table 2

Day Observed	Description of Seedlings in Control Dish	Description of Seedlings in 1% Detergent Solution	Description of Seedlings in 5% Detergent Solution
1			
2			
3			

You should keep the covers on the seed dishes so that the water won't evaporate. Observe them again each day for the next two class periods. Record the data that are called for in Tables 1 and 2.

In the meantime, check the results of Activity 5. Then go ahead to Activities 7 and 8 while you are waiting for the completion of the seed-germination time.

ACTIVITY 7: You may have noticed the tiny root hairs on the roots of the radish seedlings. Find out what role these root hairs play in the life of a plant. Your school library probably has several books and encyclopedias that can tell you more about plant growth. Record your findings in your Record Book.

ACTIVITY 8: Assume you live in a small town and you are the chairman of the city planning commission. A large detergent industry is interested in locating a new plant there. The plant would provide employment for 500 to 600 people. This would add over $1,000,000 per year to the money spent in city stores and for local services. In addition, it would mean tax money for the community. If this company locates in your town, other industries may, in turn, decide to do so. This could be the beginning of major growth for your area.

The company's president admits that the new plant may cause some detergent pollution of a nearby river. He says, however, that at this time his company could not spend more than a few thousand dollars per year in trying to eliminate this pollution.

As chairman of the city planners, you have to vote for or against allowing the industry to locate in your town. Think about the advantages and the disadvantages to your city. What additional information would help you decide how to vote? What will your vote be and why? Discuss your ideas with some of your classmates.

You should now have completed your investigation of the effects of detergent solution of the germination and growth of seeds. Be sure you have completed Tables 1 and 2 before going ahead.

Questions:

1. Did either the 1% or the 5% detergent solution seem to inhibit (slow down) the germination of the radish seeds?

2. Was the germination of the seeds affected by the detergent? If so, in what way?

3. How many of the seeds in the 5% detergent solution germinated? How many in the 1%? How many in the control?

4. Describe the differences in appearance and size (if there are any) between the control seedlings and those in the 1% and 5% detergent solutions by the time of the third observation.

5. What would you expect to happen to a farmer's crop yield if the water with which he irrigated his crops contained about 1% detergent?

DISPOSAL OPTIONS

PURPOSE: To examine disposal methods of solid wastes, comparing the advantages and disadvantages of each.

LEVEL: 4-6

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Health
Science

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Biglan, Barbara. Solid Waste: Trash or Treasure? Pittsburgh, PA: University of Pittsburgh, 1979, pp. 13-14. ED 184 864.

ACTIVITY:

1. After reading about the journey of the soda can and the test paper (page 59), encourage students to list their possible destinations as indicated in the story and any others that they know of.

2. The activity continues with an examination of these disposal options. (Waste disposal is used here to refer to collection and recycling or disposal.) A fact sheet (page 60), briefly describes six methods of solid waste disposal. Additional information can be obtained from the references listed under Resources and from local agencies or from leaders of recycling organizations.

3. In completing the "Environmental Score Card" for waste disposal options (page 61), students summarize information and identify benefits and drawbacks of each method of disposal. Review and, if necessary, explain the criteria. Note that #1-4 are considered drawbacks and that #5-8 are considered benefits. (A plus or minus might be indicated after each criterion.) Encourage students to add other criteria that they believe are important (e.g., visual appearance). Then, ask students to indicate (with an X) whether each criterion applies to each disposal option, referring to the Fact Sheet (page 60), as needed.

4. On the basis of the "Environmental Score Card" summaries, ask students to select a "best bet" for solid waste disposal and explain the reasons for their choice--in either a group discussion or an individual position paper. Alternatively, point values might be assigned to each

option (+1 for each benefit, -1 for each drawback) and the results reviewed and tallied by the class as a whole.

5. Since local municipalities have different methods of solid waste disposal, students might find out what method is used in their community. For example, a small group of students might compose a letter to their township or borough manager in which they ask about local solid waste disposal practices and regulations. Alternatively, students might plan and carry out a phone interview or a personal visit to municipal offices.

READING: Solid Wastes: What Are the Disposal Options?

Solid Waste Producer, welcome to the journey of some friends of yours. An empty soda can and that test paper from school are about to be disposed of. Their first resting place is in the garbage can. (We will not litter!) As their journey begins, there are many different paths open to them. The can and paper could be dumped. Ugh--the smell, the rats and cockroaches--a dump is not a pleasant journey's end. A better resting ground is a landfill. Here the can and paper can finish off their lives. The paper has a few weeks to live, but the can will live 400 years or more. The can and paper could both have been burned in an incineration plant. Then they would be nothing more than ashes and soot, perhaps on your clothes, car, house, and even in your lungs. How about recycling? The old can can be used to make a new can; the old paper can be made into new paper. Recycling sounds good. Or, the can and paper could be burned to produce steam which in turn would produce electricity. That empty soda can could really light up your life!

List the things that could happen to the soda can and the test paper.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Disposal Options Fact Sheet

1. City dumps or open dumps are the oldest form of waste disposal. Dumps are unpleasant to look at, smell bad, pollute water supplies, and can cause disease by attracting mosquitoes, flies, rats and other rodents. Open dumps are, however, inexpensive. Gradually, the materials left in the dump will decay.

2. Sanitary landfills are organized dumps. Wastes are packed by tractors or other heavy equipment and then covered with soil or gravel. This compaction and covering of the garbage with earth does not attract rodents and insects or pollute the air and water. Sometimes, landfills are eventually used for parks. Landfills take a long time to settle, however, and cannot be used for heavy buildings. (Also, as the garbage decays within the landfill, methane gas can be produced and work its way to the surface. Unfortunately, the gas cannot be collected for use as an energy source.)

3. Incineration is a widely used method of solid waste disposal. Burning turns tons of trash into smoke and ashes. A major drawback of traditional incineration has been air pollution, and the ash must be disposed of by dumping or landfill. However, some incineration plants have been converted to produce steam, which in turn is used to produce electricity.

4. Recycling is the processing of wastes to recover and reuse materials. For example, discarded aluminum cans can be reused to make new cans. Paper can be recycled as paper or insulation material. Glass can be recycled as road building material. Old tires can be burned with coal to generate steam. These materials need to be collected, sorted, cleaned, and transported to factories for recycling. While all this handling costs money and takes time, sometimes it is cheaper to reuse materials than to process raw materials.

5. Energy recovery or garbage pyrolysis is a process in which organic compounds are heated in an airless chamber to produce a solid, oil, and gas. These products can be used to generate electricity or to power a heating plant. A city's garbage, however, has only 1/3 the heating power of coal. And, pyrolysis is expensive and does need energy to operate. However, the energy obtained from pyrolysis is greater than the energy used.

6. Chemical treatment is a means of removing harmful substances from sewage. Chemicals are added to the sewage to produce sedimentation (settling) of harmful substances. The sediment can be further treated and then used as landfill. The remaining water can be discharged into rivers, streams, or lakes. Sometimes other waste materials can be treated with chemicals so that new usable products can be made from them. Sometimes sewage is treated with chemicals so that the wastes will not be harmful. For example, water discharged from mining operations is very acidic. By treating the acid water with chemicals, it can be neutralized. The mine water then will not be harmful to plants and animals in nearby streams.

Environmental Score Card

Criteria		Dump	Landfill	Incineration	Recycling	Energy Recovery
1. Pollutes the air						
2. Pollutes the land						
3. Pollutes the water						
4. Uses lots of energy						
5. Inexpensive						
6. Produces energy						
7. Creates new, usable products						
8. Saves nonrenewable resources						
9.						
10.						

HAZARDOUS AND TOXIC MATERIALS

TEACHING ACTIVITIES

GRADES 7-9

63 011

LETHAL LITTER-WHO PAYS?

PURPOSE: To simulate a hearing where varying viewpoints of the conditions, problems, and solutions involving the Love Canal situation are presented.

LEVEL: 7-9

FOCUS: Social/Political Aspects

SUBJECT: Social Studies

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Vivian, V. Eugene, et al. Solid Waste/Energy Curriculum. Whitesbog, NJ: Conservation and Environmental Studies Center, 1983, pp. 296-298. ED 237 355.

BACKGROUND: Improper handling and disposal of hazardous wastes have resulted in permanent damage to life and to the environment. Dangerous chemical waste sites have been found at a number of sites in the United States. They are considered to be only the tip of the iceberg. Although federal and state governments have offered to evacuate families from hazardous area locations, legal responsibility and solutions are still not known.

ACTIVITY: Read the summary on "Love Canal" below. Turn your classroom into a hearing room. Divide the class into six teams. Each team will represent one of the following groups:

-Residents of Love Canal, including lawyers to represent them;
-A legislative committee, to hear testimony;
-The chemical company's officers and lawyers;
-U. S. Environmental Protection Agency officials;
-State and other federal agency representatives;
-A scientific panel reviewing pertinent research.

Research the viewpoints of the interest group that your team represents. Try to put yourself in their shoes. Collect information that further describes the facts, viewpoints, and reactions of those in your group. A good place to find older news clippings is the "clipping file" maintained by your local

daily newspaper. Use the Reader's Guide to Periodical Literature, found in your school or local library, to retrieve information from magazines and journals.

Ask the legislative committee team to indicate the rules under which the hearing will be conducted. Select the speakers who will present the viewpoints and feelings of the people represented by your team.

Conduct the hearing as planned, then decide:

- Which groups or individuals are at fault?
- What should be done now?
- Who should pay the costs of cleanup and compensation?
- How should the victims be compensated? Can they be compensated?

Follow-up:

Locate other hazardous waste sites in the United States. Follow the same procedure in investigating them as you did for "Love Canal."

1. If you lived near Love Canal, what would you do?

2. If you worked for the Chemical Company, what would you do?

3. If you worked for the U. S. Environmental Protection Agency, what would you do?

4. If you were the President of the United States or the Governor of the State of New York, what would you do?

5. If you were a concerned citizen anywhere, what would you do?

A Summary Reading on "Love Canal":

Late in the nineteenth century a business man named John Love wanted to build a large industrial city near Niagara Falls, New York. A canal was needed to enable shipping to bypass the falls. Work on the canal started in 1893. The plan for the city and canal fell apart, but not without leaving a half-mile trench which was to have been the canal.

For the past 40 years, this 16 acre area southeast of Niagara Falls, New York, called "Love Canal," has been a dumping ground for dangerous chemical wastes. It is likely that no one thought these chemical wastes were harmful. A chemical company is known to have initiated this practice of dumping. The U.S. Department of Defense denied accusations that it too was involved. During this time, the residential district of

"Love Canal" was growing larger. Its residents knew nothing about the health hazards associated with living close to a chemical dump.

When the community decided that it needed a new school, the chemical company sold them a portion of the dumping area for one dollar. The chemical company is accused of preparing the site for construction by "capping" the dumped chemicals with a thin layer of top soil. Subsequently, the school was built on top of the dump in the early 1950's.

In the years following, new houses were built closer to the dumping site. Rain filled the dump causing chemicals to move through the soil and into the basements of Love Canal homes. Some of the chemicals oozed out of the soil to the surface. The stage for tragedy was now set.

The residents of Love Canal began to show signs of poor health, such as cancer, miscarriages, deformed babies and respiratory ailments. People suspected resurfacing chemicals as the cause. They asked for government relief. Love Canal made national headlines. Everyone blamed someone else. The chemical company, the Department of Defense, the State of New York, and the Niagara Falls School Board denied responsibility.

The residents of Love Canal were infuriated over the inaction. They formed the Love Canal Homeowners Association and hired lawyers. They brought suit against the chemical company. The case dragged on; more suits and counter suits were filed. The Environmental Protection Agency wanted 124 million from the chemical company, the State of New York wanted 600 million and the Love Canal residents wanted 10 billion dollars.

By this time, the residents of Love Canal were frightened and angry. They wanted their community declared a disaster area by the federal government so that they could receive compensation for their property and moving expenses.

More government inaction led to the abduction of two Environmental Protection Agency officials by Love Canal residents for several hours. They also burned an effigy of President Carter.

The federal government took action. Proposals included:

A "superfund" to clean up all "Love Canals" in the United States.

Money to house the people in nearby motels until Love Canal was cleaned up.

HAZARDOUS SUBSTANCES IN THE HOME

PURPOSE: To identify hazardous substances that are found in the home.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECT: Science

CONCEPTS: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

Pollutants and contaminants are produced by natural and man-made processes.

REFERENCES: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, pp. 31-35. ED 254 443.

Assaff, Edith. Hazardous Wastes: The Consumer Connection. Kalamazoo: Western Michigan University, 1984, p. 9.

ACTIVITY: Toxic or hazardous waste substances may be defined as any solid, liquid, or gaseous substances that, if disposed of incorrectly, potentially can endanger the health of individuals or harm the environment. Table I below contains a representative listing of types of such substances and their possible effects.

Table I: Hazardous Substances

TYPE	SUBSTANCE	POSSIBLE EFFECTS
Flammable	Sodium Petroleum	Explosion when exposed to oxygen
Corrosive	Acids Bases	Severe burns, damage to plant and animal life, release of heavy metals when in the soil
Heavy metals	Lead Arsenic Cadmium Mercury Zinc	Poisoning, damage to the nervous system, brain damage
Synthetic organic compounds	Industrial solvents Pesticides Insulators Herbicides	Cancer, birth defects
Infectious material	Material carrying disease-bearing organisms from labs and hospitals	Infectious diseases
Radioactive substances	Radium Uranium Plutonium	Cancer, birth defects, radiation sickness

Search your home (kitchen, basement, garage, etc.) to make a list of <u>all</u> the substances that you think could be hazardous or toxic when discarded. Compare your list with similar lists developed by your classmates; prepare a master list to be representative of the situations in the homes of class members. Table II below may also provide useful information.

Table II: The Products We Use...
The Potentially Hazardous Waste They Generate...

Plastics	Organic chlorine compounds
Pesticides	Organic chlorine compounds, organic phosphate compounds
Medicines	Organic solvents and residues, heavy metals (mercury and zinc, for example)
Paints	Heavy metals, pigments, solvents, organic residues
Oil, gasoline and other petroleum products	Oil, phenols, and other organic compounds, heavy metals, ammonia salts, acids, caustics
Metals	Heavy metals, fluorides, cyanides, acid and alkaline cleaners, solvents, pigments, abrasives, plating salts, oils, phenols
Leather	Heavy metals, organic solvents
Textiles	Heavy metals, dyes, organic chlorine compounds, solvents

A NEIGHBORHOOD SURVEY

PURPOSE: To investigate public awareness of toxic substances and to learn how people discard toxic substances, through a home toxic waste survey.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECT: Science

CONCEPT: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, p. 36. ED 254 443.

ACTIVITY: Do a home toxic waste survey. Show the list of toxic substances compiled by your class (see activity, "Hazardous Substances in the Home," pp. 68-70) to your parents and ask them how they dispose of those substances. Take the list to at least five homes in your neighborhood; tell your neighbors that you are doing a toxic waste survey for school. After defining toxic waste for them and showing them the class list, ask them to answer the following questions:

1. How many substances on the list did you realize could be hazardous?

2. What do you usually do with substances like these in your home?

    a. Throw them in the trash.

    b. Take them to the local dump.

    c. Take them to toxic waste collection sites.

    d. Keep them because you do not know how they should be discarded.

After completing your survey, answer the following questions:

1. Did your neighbors seem well-informed about toxic waste?

2. How were toxic wastes most often disposed of?

3. What was their attitude toward the survey?

4. How did you feel while doing the survey? Explain.

Compare your survey with those of your classmates. Now make a generalized statement about how home toxic substances are usually discarded.

As a follow-up, survey the teachers in the science department to find out how they dispose of toxic substances used in the lab. What kinds of safeguards do they employ? What toxic substances are disposed of? Where do they end up?

HOME HAZARDOUS WASTES

PURPOSE: To conduct a scavenger hunt to find hazardous materials in the home.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Vivian, V. Eugene, et al. Solid Waste/Energy Curriculum. Whitesbog, NJ: Conservation and Environmental Studies Center, 1983. ED 237 355.

ACTIVITY: Everyone contributes to the hazardous waste problem. People are indirectly responsible for the production of hazardous wastes by buying and using the products which create the waste. People may also contribute by discarding hazardous materials from their own homes. Examples of these materials are paint thinners, oil from the family car, insecticides or other animal poisons and strong detergents.

Your Job Is: Have a Scavenger Hunt to Find Hazardous Materials in Your House.

Many hazardous substances can be found in the home. They usually serve a useful purpose or function. The examples below will help you to begin your home search.

Hazardous Substances Commonly Found in the Home

cleaning fluids	battery acid
paint solvents	bleach
medicines	prescription drugs
weed killers	fluorescent lights
insecticides & pesticides	mercury from thermometers
oil & gasoline	asbestos insulation

These materials are called hazardous because they can harm people and/or the environment. Their characteristics are:

1. ignitability (burn or explode easily)
2. corrosivity (corrode or rust through materials)
3. toxic (can produce sickness or death in living organisms)
4. reactive (combine with other material)
5. infectious (can cause diseases in living organisms)

6. radioactive (can damage living tissue by active radiosotope decay)

When you go home tonight, search for all of the hazardous substances you can find. For each one, record the following information on the chart provided.

1. Name of material
2. Use of material; i.e. cleaning, gardening, repair, etc.
3. Hazardous characteristic; i.e. toxic, reactive, etc.
4. Disposal; i.e., discarded with household trash, transported to dump, etc.
5. Environmental effects of disposal, if known; i.e. water or air pollution, biomagnification in food chain, soil contamination, etc.

Home Hazardous Waste Chart

Products	Use	Hazardous Characteristics	How is it Disposed of?	Environmental Effects

1. Compare your chart with those of other students.

2. Which hazardous materials are most commonly found in the homes surveyed?

3. How are they disposed of?

4. Does their present disposal method harm the environment? If yes, how?

5. What are some alternatives to common disposal methods for hazardous wastes?

Student References:

Time, September 22, 1980, "Poisoning of America;" Time, October 14, 1985, "The Poisoning of America 1985."

EMERGENCY PROCEDURES

PURPOSE: To recognize indicators of poisoning and follow proper emergency procedures.

LEVEL: 7-9

FOCUS: Health Aspects

SUBJECTS: Health
Fine Arts

CONCEPT: In many cases, alternative procedures or substitute materials may be used to avoid problems inherent in the use and/or disposal of hazardous and toxic substances.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 9-12. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 6-14. ED 266 951.

ACTIVITY:

1. Simulate a poisoning in the classroom. (See pages 78-80 or use Option A or B below.)

   OPTION A: Teachers can enlist the support of students from their class or the drama department to role play an emergency situation involving a poisoning such as the one presented on pages 78-80.

   OPTION B: Using information presented on pages 79-80, describe a poison scenario. Include the behavior/actions of a poison victim. (As an alternative, you may describe the behavior/actions of a poison victim that you may have actually experienced.) After describing the behavior/actions of a possible poison scenario (such as the one on pages 79-80), have the class write down all the possible responses (both appropriate and inappropriate) that could have occurred if the situation actually happened in the classroom. (EXAMPLES: someone runs for the school nurse; students ignore the situation hoping someone else would do something, etc.) Give time for students to answer the question. When time is up, discuss the responses. To facilitate a discussion, teachers can adapt the questions provided in step 2 for use in this lesson; then, proceed with step 3.

2. Discuss the dramatization. Make several lists of student responses to the following questions. Don't put words in the student's mouths; record what is said and do not prompt the students. They will be answering these questions before receiving information on toxics. Later, you can have students review the questions after they have

been given instructions on the subject. The questions are as follows:

a. What seemed to be the problem? (Example: Student seemed "spaced out," etc.).

b. What were your (i.e., students') thoughts during the "emergency?"

c. What were we, as potential helpers, doing?

d. What should we have done? (As perceived by the students before receiving instruction.)

e. What information would you like to have had in this emergency? (e.g., cause of symptoms, emergency procedures, antidotes, phone numbers, etc.)

f. What clues were present to help us decide what happened and/or what needed to be done?

g. Did anyone think the "victim" may have been poisoned? Why?

3. Have students record the phone numbers for the Poison Control Center (if there is one in your area) and hospital emergency room. You will need to look up the numbers prior to class and give them to the students; or, the students can find the numbers as a homework assignment. Have them complete the "key word" statements on the Emergency Procedure Sheet (page 81).

SIMULATED POISONING

Introduce the "toxic chemical" unit with an "emergency." Select a student several days prior to the beginning of the unit to be the "victim" of an accidental poisoning. It is important that his/her part is rehearsed and that the students do not know that the next unit in your class is to deal with "toxic chemicals."

Have some "evidence" (e.g., labeled or unlabeled bottle of a solution or other substance near the student; an odor on the clothing) which might give a clue as to the nature of the poisoning.

Since the "emergency" involves the students in the class, it is important that the students do not perceive this as "acting." The instructor should be either disoriented or momentarily absent so that he/she is of no help to the students in the class. The "acting" should stop in a short time or whenever students begin to go for help (the school nurse and administration should be advised that students might call for help). The instructor should then bring the class back to order and discuss what happened (see step 2 of teaching procedures).

Although any toxic chemical might be used for the fake poisoning, two examples are given below. The glue will be used as an example in this lesson plan.

Product	Airplane Glue	Product	Drain Cleaning Compound
Contains	Toluol (Toluene) Hexane	Contains	Sodium hydroxide (lye)
How exposed	Inhalation	How Exposed	Ingestion
Possible Symptoms	Headache, Nausea, Drowsiness, Dizziness, Unconsciousness, Change in skin color	Possible Symptoms	Burns or redness on mouth and/or hands, Burning throat, Nausea
Precaution	Be sure that the fake victim does not become a real victim by accidentally inhaling the fumes from the glue.	Precaution	Have water in a bottle labeled sodium hydroxide.

POSSIBLE POISONING SCENARIO:

a. Instructor is taking roll.

b. "Victim" takes container of glue out of pocket so that it might be seen by another class member but not the teacher.

c. "Victim" pretends to uncap the container and sniff it. Student should hold his/her hands around the glue as it is being "sniffed." The "victim" might also try to subtly attract the attention of a classmate. The "victim" should appear very concerned about not getting caught by the teacher.

d. The "victim" pretends to screw the cap back on and then places the tube in his/her pocket or in the desk.

e. Seconds later, the "victim" acts disoriented and mumbles that his/her head hurts.

f. Victim's head "bobs."

g. Instructor is "unaware" that this is occurring. Instructor leaves classroom. Without being seen, try to observe the class while absent. You may observe something that can be used to facilitate a discussion (step m).

h. Victim's head hits the desk so that nearby students detect that something is wrong.

i. Victim should now be "unconscious with irregular breathing."

j. Allow time for students to react/not react to this "emergency."

k. Instructor returns to the room and either brings the class back to order or continues the scenario to see how the students behave.

l. The instructor should end the "emergency" at his/her discretion and explain what happened.

m. The dramatization can now be discussed.

n. Remember to collect the glue from the student before class ends.

o. It is extremely important that students do not discuss what happened with other students who might be having the same class the next period or the following day. The "surprise" element is important in this lesson.

EMERGENCY PROCEDURES

You should suspect a poisoning when somebody suddenly becomes sick or behaves in an unusual manner and there is no explanation for the illness or abnormal behavior. When this occurs, do the following in a calm, deliberate manner:

1. If poisoning is obvious, remove the poison from contact with the victim.

2. Call Poison Control Center
   (Phone No. _____)
   OR
   Hospital Emergency Line
   (Phone No. _____)

   Be prepared to give:

   a. age of victim;
   b. identity of product and ingredients;
   c. estimate of amount ingested; and
   d. symptoms.

3. If the victim is conscious, give one glass of water to dilute the "poison" and immediately telephone a medical professional or Poison Control Center for advice.

4. If you are instructed to go to an emergency room, take the poisonous substance or container with you (also vomitus if any).

5. Keep syrup of ipecac available in your home in case YOU ARE ADVISED TO USE IT to make the victim vomit.

   (It may be purchased from your pharmacist without a prescription but should only be administered on the advice of the Poison Center staff or a medical professional.)

   Memorize the key words below in the order that they are given. Complete in a brief sentence the statement which begins with the key word.

   Remove _____

   Call _____

   Don't Rely _____

   Bring _____

   Use _____

ADVERSE HEALTH EFFECTS OF HOUSEHOLD TOXICS

PURPOSE: To identify adverse health effects associated with specific chemicals.

LEVEL: 7-9

FOCUS: Health Aspects

SUBJECTS: Health
Science

CONCEPT: In many cases, alternative procedures or substitute materials may be used to avoid problems inherent in the use and/or disposal of hazardous and toxic substances.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 7-8. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 16-23. ED 266 950.

ACTIVITY:

1. Tell the students that they will learn to identify, pronounce and list adverse health effects of some chemicals commonly found in home and garden products. Although there are many potentially dangerous chemicals in household products, only a few will be covered in this lesson.

2. Tell the students that although product labels, through use of signal words, can give us a clue to the product's potential hazard, it is often difficult to judge a product's hazard by looking at the product ingredients. Some chemicals are called different names by different manufacturers. For example, toluene and toluol are the same chemical. Unless you are skilled at chemical identification, it can be difficult to truly know what you are buying.

   Some products list toxic ingredients that only contribute to immediate health risks. Toxic chemicals associated with long term health hazards may not be listed on the product label.

   We should use home and garden products with extreme care and try to reduce or avoid exposure to them whenever possible. Two ways of reducing or avoiding exposure involve: (1) buying less toxic or non-toxic products to replace household toxicants; and (2) taking precautions when using household toxics. Tell the students that later they will learn about safer alternatives to using products containing potentially toxic ingredients. This lesson will cover precautions that can be taken to reduce exposure to toxics when using them.

3. Direct the student's attention to the "Products and Precautions" information sheet (page 84). Review and discuss the PRECAUTIONS listed. Students should be aware of the reasons for taking precautions.

4. Have the students take out the Household Toxics Dictionary (pages 85-86) and the Toxic Substances Worksheet (page 87). Have the students read the directions on the worksheet and ask if there are any questions. If time permits, discuss the definitions in the Household Toxics Dictionary.

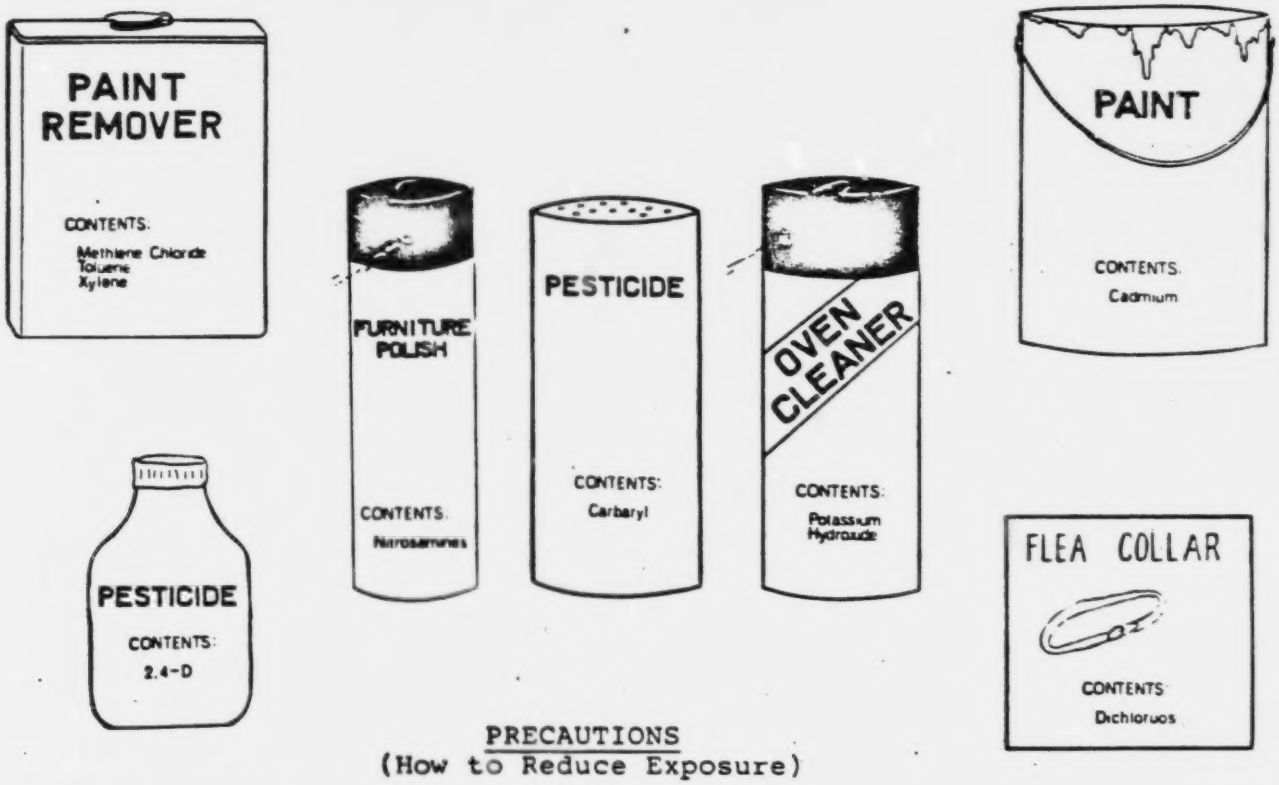
5. Have the students complete the worksheet. Allow 20 minutes. Use this time to duplicate the worksheet on the chalkboard.

6. When the time is up, discuss the students' answers to the worksheet. List their answers on the chalkboard. Discuss why students responded the way they did to the "How to Reduce Exposure" section of the worksheet. Encourage as many students as possible to give their responses.

   Using the words listed in the Household Toxics Dictionary, have the students design a crossword puzzle or word search. On a separate piece of paper, an answer sheet should also be developed. When students complete their own puzzle or word search, they can then trade with other students.

PRODUCTS AND PRECAUTIONS

(Chemicals potentially found in a few household products.)



PRECAUTIONS
(How to Reduce Exposure)

- Use in well-ventilated area.
- Avoid use of aerosols whenever possible.
- Keep products out of reach of children and pets.
- Clean up after use.
- Wear protective clothing (e.g., long sleeve shirts, heavy shoes, long pants, gloves).
- Never mix products.
- Use only the recommended amount.
- Keep products in original containers.
- Buy only what you need.
- Others? _____

_____

TOXIC SUBSTANCES MINI-DICTIONARY

The health effects listed in this dictionary are mainly focused on long term effects. This is to alert you to the potential dangers of some chemicals and the necessity for using and disposing of household toxics safely. The complete impact that a chemical may have on a person's health is not known. Also, little is known about the synergistic effects of many chemicals--that is, the effects produced when a chemical acts in combination with other chemicals. Sometimes the effect produced can be more toxic than the effects produced when the chemical acts alone.

It is important to realize that people react differently to different chemicals--some people don't even realize that their illness may be the result of exposure to chemicals in household products. For example, the headache or lightheadedness you may feel several hours after cleaning the house may be the result of inhaling toxic fumes from inadequate ventilation or from the mixing of incompatible chemicals.

Animals are generally used to determine the health effects of chemicals. Many scientists now agree that human health effects can be predicted from animal studies.

2,4-D
Causes liver and kidney damage in animals. May cause convulsions and dermatitis in humans.

cadmium (kad mē um)
Carcinogen. Causes kidney damage. Respiratory irritant.

carbaryl (kär bär il)
Suspected animal carcinogen. Also suspected of causing birth defects. May cause kidney damage.

chlordane (klor dān)
Suspected carcinogen. Causes kidney damage. Mostly affects the central nervous system, causing irritability, tremors, or convulsions.

corrosive (kor rō siv)
To eat into or wear away gradually.

dichlorvos (dī klor vōs)
Possible carcinogen. May cause gene damage.

jaundice (jän dis)
A condition in which the eyeballs, skin and urine become abnormally yellow.

ā as in ate ä as in car ē as in me

methylene chloride (meth i lēn klor īde)
Suspected carcinogen. Causes liver and kidney damage in animals.

nitrosamines (nī trōs i mēns)
Potent cancer causing agent in animals. Can cause liver damage, jaundice, and fever.

Potassium Hydroxide (pō tass ē um hī drox īde)
Extremely corrosive to all body tissues.

potent (pō tent)
Powerful

toluene (täl yoo wēn)
Possible reproductive hazard. Skin, eye, and respiratory irritant.

ventilate (ven tlāt)
To circulate fresh air through a room.

xylene (zī lēn)
Possible reproductive hazard (birth defects). Liver and kidney damage have been observed. Can cause dermatitis (inflammation of the skin).

ī as in file ō as in home

TOXIC SUBSTANCES WORKSHEET

DIRECTIONS: Pick three products from the pictures shown on the Products and Precautions Information sheet. Using the Mini-Dictionary, look up the health effects for the chemicals found in the products you choose. An example is given below. It is not necessary to list all the health effects given in the Mini-Dictionary. Under the column marked "How to Reduce Exposure," list two appropriate ways of reducing exposure to the chemical. The Products and Precautions Information sheet can assist you.

Product	Toxic Substance Contained in Product	Health Effects	How to Reduce Exposure
Example: Paint Remover	toluene	Possible reproductive hazard.	1. Avoid breathing the fumes 2. Wear protective clothing

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INDUSTRIAL WASTES

PURPOSE: To identify common sources of hazardous wastes.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECT: Science

CONCEPTS: Pollutants and contaminants are produced by natural and man-made processes.

Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

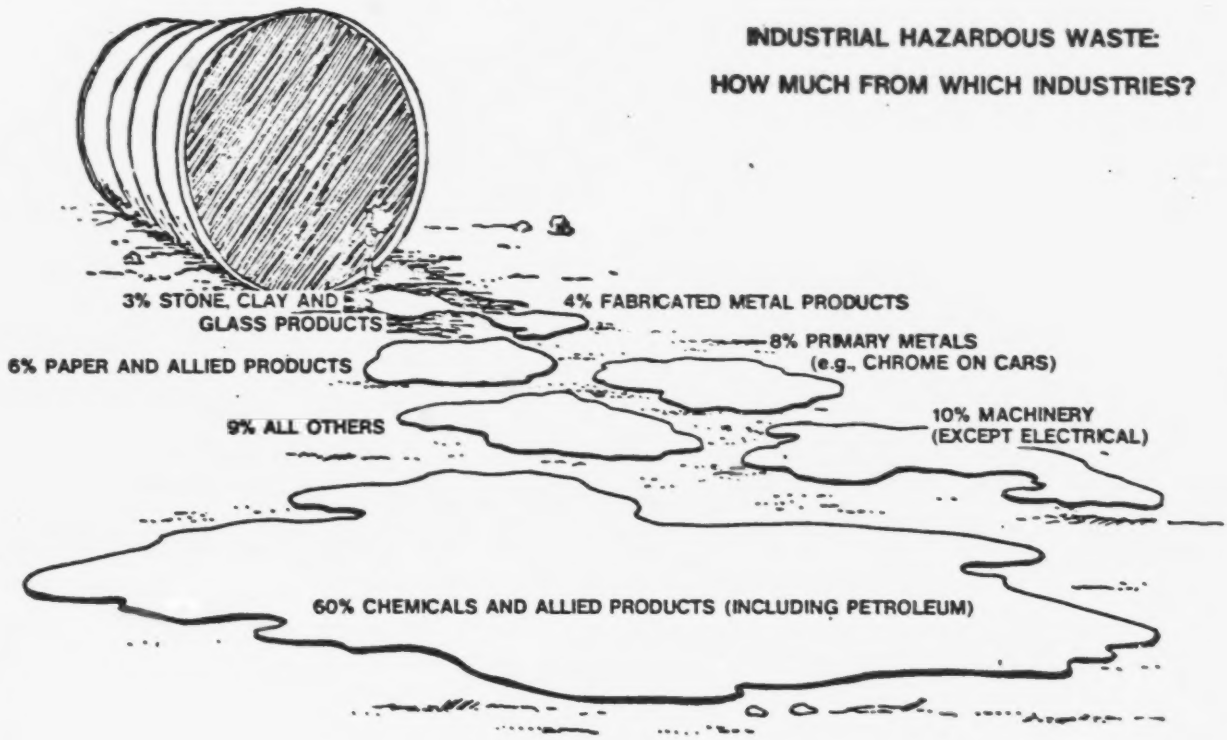
REFERENCE: Assaff, Edith. Hazardous Wastes: The Consumer Connection. Kalamazoo: Western Michigan University, 1984, pp. 9-10.

ACTIVITY: The table and figure below each provide information concerning relative amounts of hazardous waste generated by industrial and manufacturing processes. Using the information provided as a starting point, identify examples of each within your own community. This activity may be extended by seeking quantitative information from local industries. If you choose to seek such information, ask these industries to provide information as to how they seek to solve their hazardous and toxic waste disposal problems.

WHERE HAZARDOUS WASTES COME FROM

Industry	Million Metric Tons in 1977
Batteries	0.164
Inorganic Chemicals	3.900
Organic Chemicals, Pesticides and Explosives	11.666
Electroplating	4.053
Paint and Allied Products	0.110
Petroleum Refining	1.841
Pharmaceuticals	0.074
Primary Metals Smelting and Refining	8.973
Textiles Dyeing and Finishing	1.870
Leather Tanning	0.143
Special Machinery	0.153
Electronic Components	0.078
Rubber and Plastics	0.944
Waste Oil Re-refining	0.074
Total	34.043

SOURCE: Environmental Protection Agency


INDUSTRIAL HAZARDOUS WASTE:
HOW MUCH FROM WHICH INDUSTRIES?
3% STONE, CLAY AND GLASS PRODUCTS
4% FABRICATED METAL PRODUCTS
8% PRIMARY METALS (e.g., CHROME ON CARS)
6% PAPER AND ALLIED PRODUCTS
9% ALL OTHERS
10% MACHINERY (EXCEPT ELECTRICAL)
60% CHEMICALS AND ALLIED PRODUCTS (INCLUDING PETROLEUM)

Percent of Total Hazardous Waste in the United States
(Source: EPA, 1979)

CHARACTERISTICS OF TOXIC SUBSTANCES

PURPOSE: To define "toxic chemicals" and provide examples of the major categories of toxic substances.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECT: Physical Sciences

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 3-12. ED 263 015.

ACTIVITY: This is a teacher-demonstration for the physical, life, earth, or general science class. The chemical aspects of this demonstration should be completed under a hood and, if one is not available, it should be done outside when the weather is dry. The teacher must practice the experiments using appropriate safety precautions such as goggles, hood, remote handling and control devices, gloves and laboratory apparel. The students should not be permitted to do these experiments on their own. The teacher should provide proper disposal of materials remaining after experimentation.

For demonstration of toxicity, photographs from magazines or newspaper pictures of fish kills are appropriate. A dead plant or the remains of a flower could be used effectively. The instructor may want to develop a series of slides to show responses of biological systems to toxins, chemicals and environmental changes. The dangers of large scale duplication of any dangerous demonstrations should be emphasized by the teacher. Students may be asked to know 10 substances from the list of toxic pollutants. They may also be asked to research the use and characteristics of some of the other chemicals on the list.

For some highly effective demonstrations of the characteristics of a toxic substance, the teacher may want to invite the local fire department and its Hazardous Incident Team in for a demonstration. This demonstration would probably be done outside or at their training site. Some states have special hazardous incident teams affiliated with their health departments, state police and office of emergency services. It is suggested that the teacher consider asking them to give a demonstration, to provide films, video tapes or

interact with their training officer or an official in a private hazardous waste disposal firm. Even if only photographs are available and an emergency telephone number is all that is gained, it will be useful.

BACKGROUND: Defining a toxic substance is not easy. The following interpretations are from the book, "The Toxic Substances Dilemma" edited by Segel, Kamlet, Clark, Veraska and Lowe (National Wildlife Federation, 1980). "Congress avoided an explicit definition of 'toxic' in passing the Toxic Substances Control Act (TSCA) and failed to even use the term 'toxic' except in the title. The EPA, which has the responsibility of enforcing the act stated, 'The main obstacle is the lack of a precise or even a semi-precise definition of what constitutes a toxic material. The line of demarcation between a toxic and a non-toxic material is so ambiguous that it is almost hopeless...'"

"In the broadest sense, a toxic substance is one which can produce some adverse biological effect or damage in a living organism, be it man, animal, plant or other system. But this definition is not very helpful. Every chemical can be toxic if too much of it is present, that is, if its concentration is too high for the particular circumstance. Water is toxic to a person submerged in it. It has been said that there are no harmless substances, only harmless ways of using substances. Strychnine is harmless as long as it remains in a sealed vial. Drinking excessive amounts of water can kill."

The Toxic Substances Control Act covers these two main points in an attempt to protect human health and the environment:

1. Human beings and the environment are being exposed each year to a large number of chemical substances and mixtures; and

2. Among the many chemical substances and mixtures which are constantly being developed and produced, there are some whose manufacture, processing, distribution in commerce, and use or disposal may present an unreasonable risk of injury to health or the environment.

Congress has thus defined a toxic substance as a chemical or mixture whose manufacture, processing, distribution, use, or disposal may present an unreasonable risk of injury to health or the environment. Such substances or mixtures are the ones to be regulated. The key words in this definition are "unreasonable risk."

A toxic substance or toxic chemical usually has value and a definite use. A hazardous waste or toxic waste is often

characterized as being toxic and "dangerous" but having little or no use and no economic value. Thus, there is a need to dispose, recycle, neutralize, store or just simply make sure that such materials are not dumped into the environment.

"The terms "pollutant" and "toxic substance" are often used interchangeably. This usage is convenient but misleading and imprecise. Just as all cats are animals, but not all animals are cats--all toxic substances are pollutants, but not all pollutants are toxic substances. Pollutants, in the broadest sense, are all materials which enter the environment as a direct or indirect result of man living on earth. Pollutants thus include human biological wastes, garbage, the smoke from cigarettes and factory smokestacks, the emissions from homes, offices, cars, trucks and industrial plants. Environmentalists also classify as pollutants excessive amounts of noise and heat. The latter is often in reference to water being returned after use as a coolant. Pollutants may or may not be harmful to human beings and the environment, and may or may not be harmlessly absorbed by the environment. Not so with toxic substances. A pollutant is a toxic substance when it causes an unreasonable risk to human health or the environment. Deciding which pollutants are toxic substances can be complex and difficult." (Segal, et al., 1980)

Toxic substances are chemicals or materials which can harm, contaminate, or kill living organisms because they have ignitable, corrosive, reactive or toxic characteristics. They may be primary products or produced as by-products of chemical and industrial production. They may be toxic wastes because they seemingly have no other use. The four main characteristics of toxic substances are:

1. Toxicity - poisonous and harmful to human health. These substances can kill (toxic and lethal), cause cancer (carcinogens), cause birth defects (teratogens), alter genetic material (mutagens) or harm or kill fish, wildlife and in some cases, even humans.

2. Corrosiveness - can corrode storage containers or damage human tissue if touched.

3. Reactiveness - unstable and could react if exposed to heat, shock, air or water.

4. Ignitability - could explode, catch on fire or emit toxic gases into the environment.

Examples of toxic substances are DDT, asbestos, cyanide, lead, PCB's, mercury, and kepone. Since many students do not understand the above terms, this lesson seeks to illustrate safely and somewhat vividly, via demonstration, guest lecture, or film, these characteristics.

DEMONSTRATIONS

ALL EXPERIMENTS AND DEMONSTRATIONS REQUIRE THE USE OF SAFETY GLASSES AND APRONS

Toxicity

Photographs from magazines, slides or newspaper articles, pictures of dead animals, plants or fish kills can be used to illustrate the lethal aspect of toxicity.

Toxicity can be acute, causing death in a short time period, usually in less than a week or a month, or it can be chronic, leading to illness and eventual death after months or years of exposure to the agent. Normally we think of toxicity as acute, causing immediate or near immediate death.

The amount of agent causing death is often related to the time it takes to kill the organism and the number of organisms (%) killed. A commonly used procedure is that of determining the LD_{50}, lethal dose to 50% of the organisms. Also the LC_{50}, lethal concentration which the organism lives in that will cause 50% of them to die. The latter is usually associated with fish and aquatic organisms. For the LD_{50}, the amount of toxin is usually considered in relation to the mg of toxin administered or fed to an organism based on its body weight in kg. Since few test organisms weigh one kg, proportional calculations are applied to the amount of toxin required to kill 50%, yet toxic amounts are usually reported in mg/kg of organism.

An experiment that the students could do or the teacher could demonstrate involves the use of milkweed bug eggs. Other beetle/insect eggs that are available can also be used. Such eggs (milkweed bug) are available from biological supply dealers; sufficient amounts for demonstrations and the starting of a culture are relatively inexpensive. Cultures may be maintained indefinitely. The eggs are microscopic and would require the use of a hand lens or stereomicroscope and a dissecting needle to tease apart and move the eggs. They are yellow, change color, and emerge from the egg case if they hatch. Thus it is possible to set up the following experiment to show the effect of exposures to various chemicals such as salt water or insecticides on the percent hatchability and time to hatch of these eggs. It is suggested that you start your own colony of bugs and collect the eggs as they are laid. There is no fear that this strain will escape and become a problem in the environment or into the building because they have been adapted to feed and they can survive only upon raw and unsalted sunflower seeds.

Make a salt solution of 10 grams/100 ml and dip 10 eggs into it for 30 seconds, 10 eggs for 1 minute and so on for up to 5 minutes. Rinse the eggs immediately after removal with tap water from a medicine dropper. Treat another set of eggs (control) only with tap water also for the same interval of time. A teabag strainer will serve as a dipping instrument. Remember to rinse it between uses. Collect the eggs on filter paper and

label their time of exposure and treatment. Observe them daily for up to 10 days, recording date and number hatching.

Have the students determine the length of time of exposure to the salt water or the insecticide that causes a 50% loss in hatchability. In a way they are determining the lethal time for 50% of the hatchable eggs.

This is a long-term experiment and would be a good project for several students which could provide the beginnings for a competitive "fair" project. It may require up to a month to raise sufficient animals for egg production. The use of salt solutions are recommended over that of insecticides or other more dangerous chemicals and metal-containing compounds.

Corrosiveness

Place a plain iron (steel, non-coated, non-galvanized) nail into a 10% solution of copper sulfate (10 g/100 ml water). After a few minutes the part of the nail that is in the solution will be noticeably reduced in size. This is an example of corrosion.

An alternative method is to place a small wad of fine steel wool in water. After a few hours, the rust or corrosion will be evident.

Dispose of these chemicals via approved procedures which is usually to an appropriate landfill.

You may want to discuss other examples of corrosion with your students. These could include that of a strong acid (and the warning symbol for this) or the oxidation of aluminum.

Reactiveness

For reactiveness and ignitability, a film or tape may be used, or a demonstration by a professional hazardous incident team specialist. The classic examples of using a small piece of sodium metal and water, even if a hood is available, is not recommended.

A recommended experiment is to add 10 grams of baking soda to 100 ml of vinegar. The reaction will be rapid and it will fizz. Be sure that the beaker is at least a 500 ml size to contain the reaction. Better yet, utilize some powder or a tablet of an effervescent agent such as "Alka-Seltzer" in water to produce the bubbling effect from the carbon dioxide/carbonic acid. A 3 - 4 gram tablet of denture cleanser such as Efferdent can be placed in 8 ounces of warm water and the reaction will be dramatic with a blue color first, followed by the clearing of the color. Each of the above reaction products may be diluted and safely disposed of via the normal sewage system.

Ignitability

Strike a match. The reaction produces a flame which illustrates ignitability by addition of heat, by friction from the box. Utilize a safety match and discuss the chemicals and heat involved.

As an alternative demonstration, use a camera and flash bulb, taking care not to flash the bulb directly and at close distance into the eyes and remembering that the bulb is hot for a minute or two after the flash. Ask the student to explain the ignition of the magnesium filament and why it is contained within glass or plastic. Have several types of flash bulb that have been opened before and after flashing. Enclose these bulbs in sealed Petri dishes so they do not disappear. Give the students a history of some of the accidents associated with flashing devices used by early photographers but do not demonstrate the burning of magnesium ribbon unless you have a hood and eye protection.

A film or video-tape reaction that is a dramatic example of reactiveness and ignitability involves the use of solid swimming pool bleach and brake fluid. This should not be done by the teacher even if a hood is available. A film or field trip to show this type of demonstration is recommended. Consider having the local hazardous incident team demonstrate this.

The reaction above is exothermic and liberates 60% free chlorine gas, so an explosion-proof hood or outside open field is needed. The dryer the bleach (sodium hypochlorite ($NaHClO_3$)), the slower the reaction. If a plastic cup is used and it burns there will be some hydrocyanic gas with an almond smell. It is also dangerous. The brake fluid is a hydrocarbon.

SHORT ANSWER QUESTIONS

1.	List the four main characteristics of a toxic substance.	corrosive toxic reactive ignition
5.	Pollutants are always toxic.	No
6.	Hazardous waste normally has substantial value.	False/no
7.	The abbreviation for 50% lethality is	LD_{50}
8.	Give the term used for a chemical that causes cancer.	carcinogen
9.	Is asbestos a toxic pollutant and on the priority list?	yes
10.	Who proposed the Priority Toxic Pollutant List?	EPA

1. Priority Toxic Pollutants

1. *acenaphthene
2. *acrolein
3. *acrylonitrile
4. *benzene
5. *benzidine
6. *Carbon tetrachloride (tetrachloromethane)
   chlorinated benzenes (other than dichlorobenzenes):
7. chlorobenzene
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene
   *chlorinated ethanes (including 1,2-dichloroethane, 1,1,1-trichloroethane and hexachloroethane):
10. 1,2-dichloroethane
11. 1,1,1-trichloroethane
12. hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane
    *chloroalkyl ethers (chloromethyl, chloroethyl and mixed ethers):
17. bis (chloromethyl) ether
18. bis (2-chloroethyl) ether
19. 2-chloroethyl vinyl ether
    *chlorinated naphthalene:
20. 2-chloronaphthalene
    *chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols):
21. 2,4,6-trichlorophenol
22. parachlorometa cresol
23. *chloroform (trichloromethane)
24. *2-chlorophenol
    *dichlorobenzenes:
25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene
28. 3,3-dichlorobenzidine
    *dichloroethylenes (1,1-dichloroethylene and 1,2-dichloroethylene):
29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. *2,4-dichlorophenol
    *dichloropropane and dichloropropene:
32. 1,2-dichloropropane
33. 1,2-dichloropropylene (1,3-dichloropropene)
34. *2,4-dimethylphenol
    *dinitrotoluene:
35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
37. *1,2-diphenylhydrazine
38. *ethylbenzene
39. *flouranthene
    *Haloethers (other than those listed elsewhere):
40. 4-chorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis (2-chloroisopropyl) ether
43. bis (2-chloroethoxy) methane
    *halomethanes (other than those listed elsewhere):
44. methylene chloride (dichloromethane)
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. trichloroflouromethane
50. dichlorodiflouromethane
51. chlorodibromomethane
52. *hexachlorobutadiene
53. *hexachlorocyclopentadiene
54. *isophorone
55. *naphthalene
56. *nitrobenzene
    *nitrophenols (including 2,4-dinitrophenol and dinitrocresol):
57. 2-nitrophenol
58. 4-nitrophenol
59. *2,4-dinitrophenol
    *nitrosamines:
60. 4,6-dinitro-o-cresol
61. N-nitrosodimethylamine
62. N-nitrosodiphenylamine
63. N-nitrosodi-n-propylamine
64. *pentachlorophenol
65. *phenol
    *phthalate esters:
66. bis (2-ethylhexyl) phthalate
67. butyl benzyl phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate
    *polynuclear aromatic hydrocarbons
72. benzo (a) anthracene (1,2-benzanthracene)
73. Benzo (a) pyrene (3,4-benzopyrene)
74. 3,4-benzoflouranthene
75. benzo (k) flouranthene (11,12-benzoflouranthene)
76. chrysene
77. acenaphthylene
78. anthracene
79. benzo (ghi) perylene (1,2-benzoperylene)
80. phenanthrene
81. fluroene
82. dibenzo (a,h) anthracene (1,2,5,6-dibenzanthracene)
83. indeno (1,2,3-cd) pyrene 2,3-o-phenylenepyrene)
84. pyrene (mixed)
85. *tetrachlorethylene
86. *toluene
87. *trichloroethylene
88. *vinyl chloride (chloroethylene)
    pesticides and metabolites:
89. *aldrin
90. *dieldrin
91. *chlordane (technical mixture & metabolites)
    DDT and metabolites
92. 4,4'-DDT
93. 4,4'-DDE (p.p'-DDX)
94. 4,4'-DDD (p.p'-TDE)
    *endosulfan and metabolites:
95. a-endosulfan-Alpha
96. b-endosulfan-Beta
97. endosulfan sulfate
    *endrin and metabolites:
98. endrin
99. endrin aldehyde
    *heptachlor and metabolites:
100. heptachlor
101. heptachlor epoxide
102. a-BHC-Alpha
103. b-BHC-Beta
104. r-BHC (Lindane)-Gamma
105. g-BHC-Delta
    *polychlorinated biphenyls (PCB's)
106. PCB-1242 (Arochlor 1242)
107. PCB-1254 (Arochlor 1254)
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
110. PCB-1248 (Arochlor 1248)
111. PCB-1260 (Arochlor 1260)
112. PCB-1016 (Arochlor 1016)
113. *Toxaphene
114. *Antimony (Total)
115. *Arsenic (Total)
116. *Asbestos (Fibrous)
117. *Beryllium (Total)
118. *Cadmium (Total)
119. *Chromium (Total)
120. *Copper (Total)
121. *Cyanide (Total)
122. *Lead (Total)
123. *Mercury (Total)
124. *Nickel (Total)
125. *Selenium (Total)
126. *Silver (Total)
127. *Thallium (Total)
128. *Zinc (Total)
129. *2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

*Specific compounds and chemical classes as listed in the consent decree.

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2. Priority Toxic Pollutants By Classes

Pollutant	Characteristics	Sources
Pesticides Generally chlorinated hydrocarbons	Readily assimilated by aquatic animals, fat soluble, concentrated through the food chain (biomagnified), persistent in soil and sediments	Direct application to farm and forestlands, runoff from lawns and gardens, urban runoff, discharge in industrial wastewater
Polychlorinated biphenyls (PCB's) Used in electrical capacitors and transformers, paints, plastics, insecticides, other inustrial products	Readily assimilated by aquatic animals, fat soluble, subject to biomagnification, persistent, chemically similar to the cholorinated hydrocarbons	Municipal and industrial waste discharges disposed of in dumps and landfills
Metals Antimony, arsenic, beryllium, cadmium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc Other inorganics Asbestos and cyanide	Not biodegradable, persistent in sediments, toxic in solution, subject to biomagnification Asbestos May cause cancer when inhaled, aquatic toxicity not well understood Cyanide Variably persistent, inhibits oxygen metabolism	Industrial discharges, mining activity, urban runoff, erosion of metal-rich soil, certain agricultural uses (e.g., mercury as a fungicide) Asbestos Manufacture and use as a retardant, roofing material, brake lining, etc.; runoff from mining Cyanide Wide variety of industrial uses
Halogenated aliphatics Used in fire extinguishers, refrigerants, propellants, pesticides, solvents for oils, and greases, and a dry cleaning	Largest single class of "priority toxics," can cause damage to central nervous system and liver, not very persistent	Produced by chlorination of water, vaporization during use
Ethers Used mainly as solvents for polymer plastics	Potent carcinogen, aquatic toxicity and fate not well understood	Escape during production and use
Phthalate esters Used chiefly in production of polyvinyl chloride and thermoplastics as plasticizers	Common aquatic pollutant, moderately toxic but teratogenic and mutagenic properties in low concentrations; aquatic invertebrates are particularly sensitive to toxic effects; persistent; and can be biomagnified	Waste disposal vaporization during use (in nonplastics)
Monocyclic aromatics (excluding phenols, cresols and phthalates) Used in the manufacture of other chemicals, explosives, dyes and pigments, and in solvents, fungicides, and herbicides	Central nervous system depressant; can damage liver and kidneys	Enter environment during production and by-product production states by direct volatilization, wastewater
Phenols Large volume industrial compounds used chiefly as chemical intermediates in the production of synthetic polymers, dyestuffs, pigments, pesticides, and herbicides	Toxicity increases with degree of chlorination of the phenolic molecule; very low concentrations can taint fish, flesh and impart objectionable odor and taste to drinking water; difficult to remove from water by conventional treatment; carcinogenic in mice	Occur naturally in fossil fuels, waste water from cooking ovens, oil refineries, tar distillation plants, herbicide manufacturing, and plastic manufacturing; can all contain phenolic compounds
Polycyclic aromatic hydrocarbons Used as dyestuffs, chemical intermediates, pesticides, herbicides, motor fuels, and oils	Carcinogenic in animals and indirectly linked to cancer in humans; most work done on air pollution, more is needed on the aquatic toxicity of these compounds, not persistent and are biodegradable though bioaccumulation can occur	Fossil fuels (use, spills, and production), incomplete combustion of hydrocarbons
Nitrosamines Used in the production of organic chemicals and rubber; patents exist on processes using these compounds	Tests on laboratory animals have shown the nitrosamines to be some of the most potent carcinogens	Production and use can occur spontaneously in food cooking operations

From: Environmental Quality, Ninth Annual Report of the Council on Environmental Quality. U.S. Government Printing Office, Stock No. 041-011-00040-8, December, 1978.

WORD GAMES

PURPOSE: To identify terms associated with toxic substances and hazardous wastes, using word games.

LEVEL: 7-9

FOCUS: General Aspects

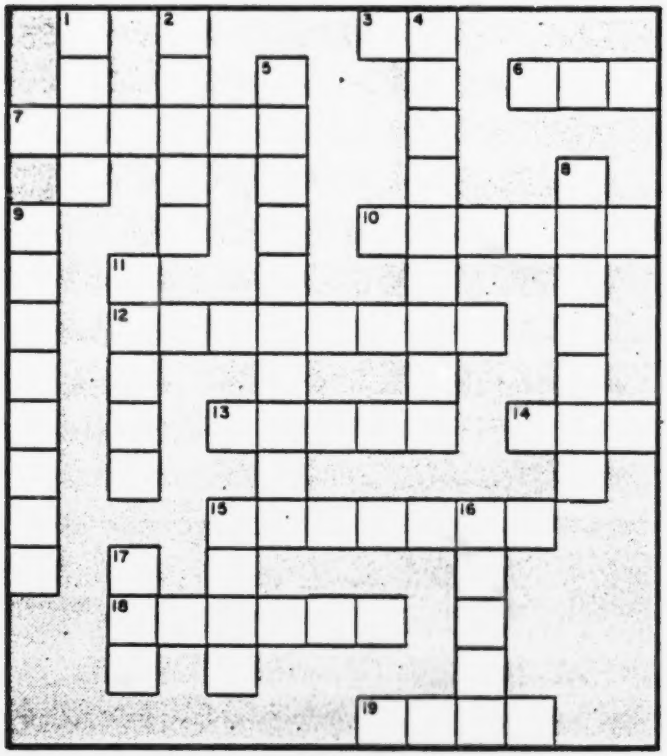
SUBJECT: Science

CONCEPT: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 41-46. ED 263 015.

ACTIVITY: Word games may be used to reinforce vocabulary at a time when review is necessary. They have limited educational value, but can serve to challenge students as a change of pace or as a break from classroom routine. Four such games are described below, with answers following. Teachers may wish to encourage students to write their own questions and construct similar games. Because these puzzles were constructed for use in classrooms in Virginia, some modifications may be needed to reflect local conditions and circumstances.

VOCABULARY CROSSWORDS



ACROSS

3. Acidity scale
6. Polychlorinated biphenyls (abbr.)
7. Toxin in Agent Orange
10. Abandoned dump site
12. Fiberous mineral
13. River polluted by kepone
14. Petroleum
15. To use again
18. Containing tiny holes
19. Occupational Safety & Health Act (abbr.)

DOWN

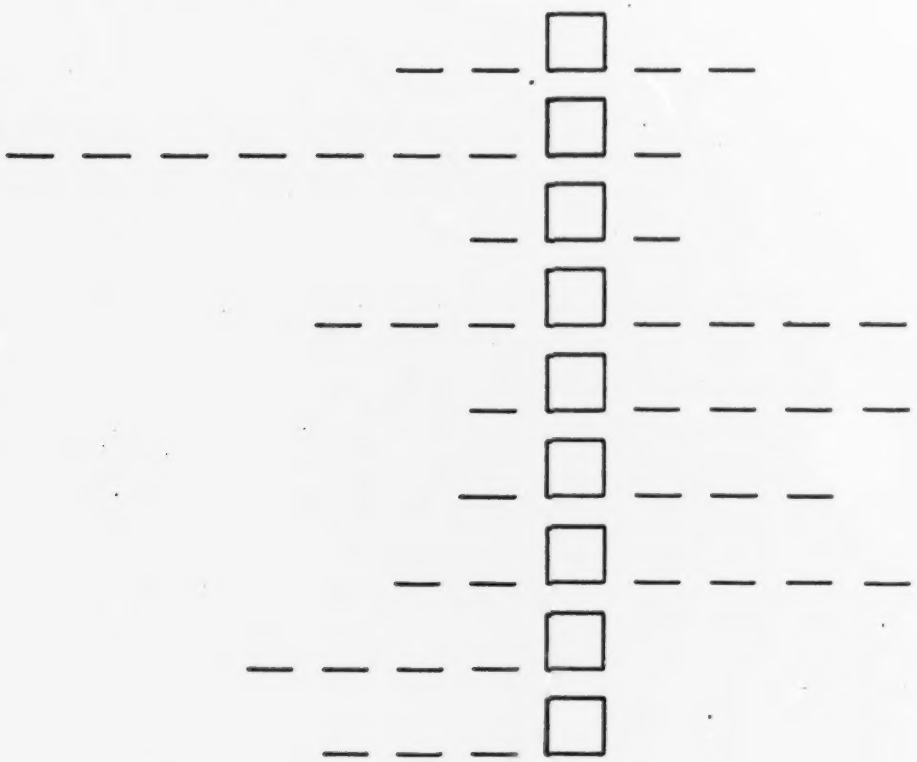
1. Toxic Rain
2. Poisonous, causes health problems
4. Risky, dangerous
5. To burn waste
8. Action of a base
9. Papers that follow transported waste
11. Useless, discarded material
15. Resource Conservation & Recovery Act (abbr.)
16. To filter through
17. Environmental Protection Agency (abbr.)

WHAT AM I???

Instructions: What government project is responsible for the clean-up of abandoned dump sites? Find the words that answer the clues to find out who our muscular friend is.

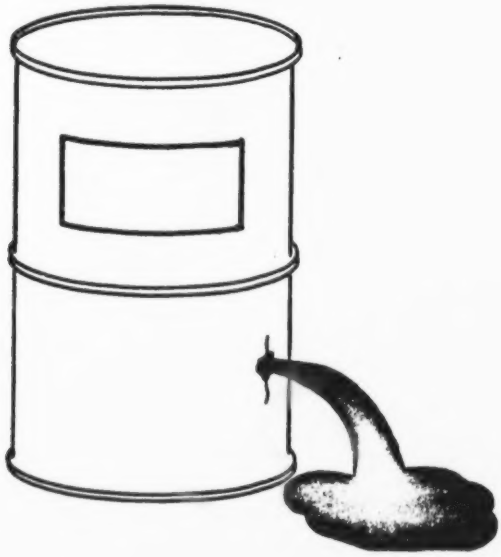
CLUES

1. Useless matter, discarded material
2. Risky, dangerous
3. Environmental Protection Agency (abbr.)
4. Fiberous mineral
5. Abandoned landfill
6. Where wastes are buried
7. Action of a base
8. Toxic substance in Agent Orange
9. Hazardous rainfall



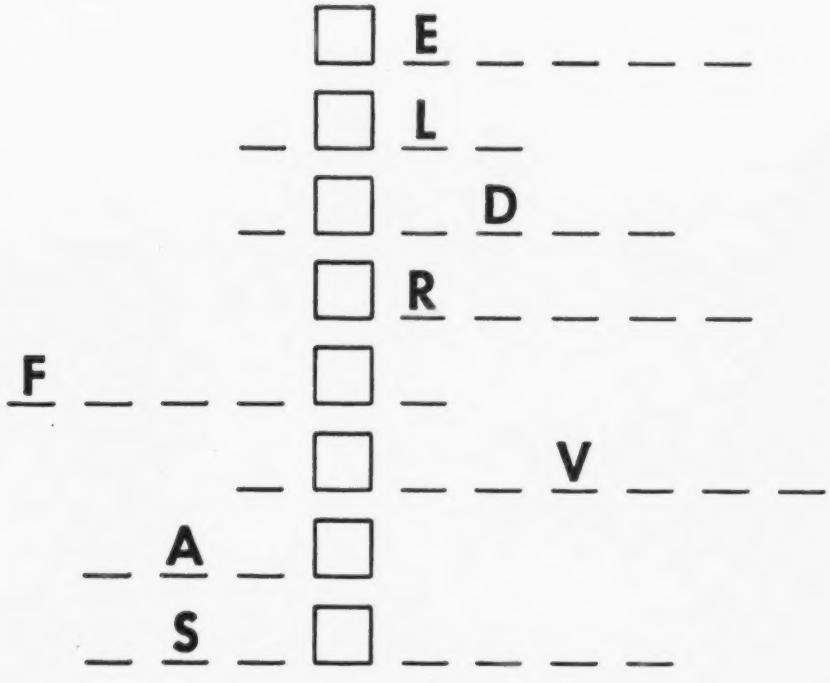
WHAT'S LEAKING ???????

Instructions:
This leaking container needs to be cleaned up. But how? The container is unlabeled and therefore, potentially dangerous. Can you help identify the contents?



CLUES

1. Toxic substance found in the James River in VA
2. Section of a landfill
3. _____ to grave
4. Agent _____
5. Waste from smoke stacks
6. Resource Conservation and _____ Act
7. Acid _____
8. Fiberous mineral



SEEK AND FIND THE WORDS - TOXIC SUBSTANCES & HAZARDOUS WASTES

Instructions: Hidden words listed on the left appear forward, backward, up, down or diagonally. Find each word and circle it. Record the length of time necessary to complete the exercise.

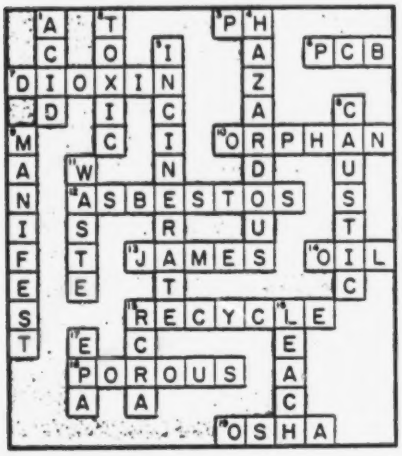
WORDS

Barrels
Cats
Chemical
Chickens
Congress
Contaminated
Dangerous
Dioxin
Disposal
Dogs
Doomsday
EPA
Flood
Guidelines
Hazardous
Horses
Inhaling
Lagoon
Meramec River
Michigan
Missouri
New Jersey
Officials
Poisonous
Respirators
Sample
Site
Superfund
Technicians
Toxic
Toxins
Wastes

W	A	S	T	E	S	C	N	T	M	S	G	O	D	S
S	U	O	N	O	S	I	O	P	E	P	A	P	O	A
D	I	S	P	O	S	A	L	T	R	N	E	L	O	M
T	C	U	B	U	N	G	O	C	A	T	S	F	M	P
K	C	O	N	G	R	E	S	S	M	S	P	R	S	L
H	O	R	S	E	S	T	N	C	E	E	L	I	D	E
L	E	E	T	D	S	I	T	E	C	T	A	D	A	S
W	X	G	K	O	X	N	T	B	R	S	G	L	Y	C
S	C	N	T	O	X	I	C	N	I	A	O	E	T	P
B	K	A	I	L	T	W	O	G	V	W	O	Y	C	N
O	T	D	B	F	U	N	C	H	E	M	N	O	T	C
S	A	M	P	L	S	L	E	R	R	A	B	I	D	N
C	H	E	M	I	C	A	L	T	O	P	M	N	E	S
V	A	T	M	I	S	S	O	U	R	I	I	H	T	N
O	F	F	I	C	I	A	L	S	B	J	C	A	A	A
T	O	N	T	O	X	I	N	S	C	B	H	L	N	I
G	U	I	D	E	L	I	N	E	S	S	I	I	I	C
S	R	O	T	A	R	I	P	S	E	R	G	N	M	I
S	N	E	K	C	I	H	C	P	C	B	A	G	A	N
N	E	W	J	E	R	S	E	Y	O	T	N	O	T	H
H	A	Z	A	R	D	O	U	S	L	O	P	E	N	C
B	S	U	P	E	R	F	U	N	D	C	N	T	O	E
M	O	S	C	O	W	M	I	L	L	S	I	C	C	T

KEYS/ANSWERS/SOLUTIONS

VOCABULARY CROSSWORDS



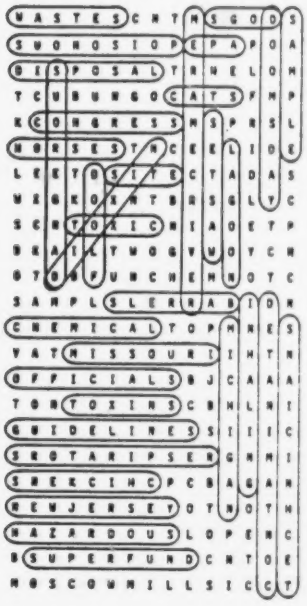
WHAT AM I???

WASTE
HAZARDOUS
EPA
ASBESTOS
ORPHAN
LANDFILL
CAUSTIC
DIOXIN
ACID

WHAT'S LEAKING???

KEPONE
CELL
CRADLE
ORANGE
FLYASH
RECOVERY
RAIN
ASBESTOS

SEEK AND FIND THE WORDS



ACKNOWLEDGEMENTS

This edited version was originally prepared and evaluated by Willard W. Wilson, Jr., a faculty member at Mosby Middle School, Richmond, VA and by Elaine P. Woodard, Powhatan Middle School, Powhatan, VA. Mrs. Woodard developed the Seek and Find puzzle. Mr. Wilson is responsible for developing and testing the first three word puzzles.

CARTOONS ARE NOT NECESSARILY FUNNY

PURPOSE: To develop skills in interpretation and analysis and to identify misconceptions about toxic substances through the medium of cartoons.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECTS: Social Studies
Fine Arts
Science

CONCEPT: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 57-64. ED 263 015.

ACTIVITY: Cartoons may be used to help students learn to analyze for deeper meanings while becoming aware of various aspects of environmental issues, including those related to hazardous and toxic materials. They have proved successful in making students aware of different aspects of these problems by identifying values expressed by the cartoons, appreciating the importance of distinguishing fact from opinion, and drawing defensible conclusions from their analyses.

Reading or interpreting cartoons requires the ability to identify symbols used, the cartoonist's purpose, and the situation being depicted. The cartoons may make use of exaggeration, oversimplification, caricature, stereotypes, or satire.

Cartoons relating to many aspects of the toxic substances problem can be found in newspapers and magazines. These have become increasingly prevalent in recent years. Teachers should collect several examples to initiate this activity.

A TSSPP/approach (title, symbols, situation, purpose, point-of-view) may be taken to take a political or editorial cartoon and analyze it to reveal its elements and intentions:

Title: What is it? Does it mean something specific? Why was it chosen?

Symbols: What do they mean? Are there clues to meaning in the title?

Situation: What is happening? Who is doing what to whom and why?

Purpose: Is the cartoon trying to explain? to poke fun? to arouse?

Point-of-View: Does the cartoon show bias? Are there distortions which may be clues to how the cartoonist feels?

At first, use this method with the class a few times before having students attempt to analyze cartoons independently. Use individual copies of the same cartoon or an overhead transparency to teach the method to the students.

Following this, have students analyze cartoons which they have brought to class from newspapers and magazines. These cartoons should illustrate some question or situation arising from hazardous and toxic substances concerns. Teachers should be prepared to provide cartoons to those students who do not have access to newspapers and magazines. This should be done as an in-class assignment, so that help can be provided to students having difficulty. Student analyses should be based on the TSSPP outline. After analyses have been written, cartoons may be exchanged and analyzed, and analyses compared by pairs or groups of students.

Students can be assigned to create their own cartoons which illustrate a situation, controversy, or problem arising from the toxic substances problem, allowing them to be creative while using critical thinking skills. Any evaluation of student efforts should be based on evidence of understanding, not artistic ability. The following procedures may be used to guide this portion of the activity:

1. Make the assignment as specific as possible. Ask for a cartoon about a particular topic or provide a list of topics to be chosen from, such as:

   - asbestos
   - formaldehyde
   - agent orange
   - Love Canal
   - mercury poisoning
   - lead poisoning
   - nuclear wastes
   - hazardous waste dumps
   - kepone
   - insecticides
   - uranium mining
   - Superfund

2. Specify the size of the finished product; announce a deadline.

3. Suggest that students read editorial cartoons and comic strips with an eye to understanding why something is or is not "funny to me."

4. Grade cartoons on creativity displayed.

5. When the first cartoons are turned in, discuss and analyze them in class. After discussion, repeat the assignment so that students have a chance to improve their original cartoons and/or to begin with fresh ideas. The best cartoons and the most learning will usually be on the second or third cartoon.

6. Offer the best of the cartoons to the school or local newspaper for public display. Arrange a bulletin board of cartoons in a prominent area of the classroom or the school.

HAZARD!

PURPOSE: To provide information about the problems associated with hazardous wastes (economics, politics, health effects, disposal), using a game format.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECTS: Science
Social Studies

CONCEPT: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

REFERENCE: Ohio Cooperative Extension Service. Hazardous Wastes, Two Games for Teaching about the Problem. Environmental Communications Activities, Bulletin 703. Columbus: The Ohio State University, OCES, 1983. ED 226 999.

ACTIVITY: The value of property and the quality of life are often determined by subjective perceptions. For instance, citizens generally view industry locating in their area as a good thing, even if that industry generates or handles hazardous wastes. They view it as good because jobs are provided and the local economy gets a boost, as do property values.

Bolstered by jobs and economic security, people tend to feel that they are living a life of quality as well. If hazardous waste facilities can be viewed as legitimate industry, property values and the perception of quality of life probably will not decrease in any given area. But in order for hazardous waste facilities to gain legitimacy, people have to accept their presence as a necessity in a highly industrialized society. Without them, hazardous wastes cannot be safely treated and disposed of.

It is necessary to become informed about these wastes and the technologies available to control them. If the premise is that hazardous wastes can be controlled through proper disposal, this must be communicated. Citizens must become a part of the participation process, especially if hazardous waste facilities are planned for their areas. The question then becomes, does society continue to permit the indiscriminate dumping of wastes, or does it begin to control them and dispose of them properly?

The use of gaming provides opportunity to simulate "real-world" situations and to gain insight into choices which are available. Such a game is described below. In presenting, discussing, and summarizing such games, teachers must be careful to stress the differences between "winning a game" and accomplishing a socially, environmentally acceptable goal.

Hazard: A board game for two to five players.

A. Materials: Game board (pages 111-114), one die, place markers (p. 110), Hazard Cards (pages 115-117), Waste Cards (p. 118), Disposal Cards (p. 119), money (p. 120), and Insurance Cards (p. 110).

B. To Start: Shuffle the Hazard cards and place them face down on the board. Choose a banker who will be in charge of dispensing and collecting money, Waste cards, Disposal cards, and Insurance cards.

Each player (up to four) chooses a truck as a place marker. Players represent transporters of hazardous wastes. If there are five players, the fifth person is the banker.

C. Playing the Game: Roll the die. High number starts first; others take turns going clockwise. The banker gives each player $10,000.

The first player places his marker on the START HERE space and rolls the die. The roll determines the number of spaces to be moved. Notice there are five kinds of spaces on the board:

Reward, penalty or no action takes place when you LAND IN a white space.

You must LAND IN a space to take an opponent to court.

When you LAND IN or PASS a option space, you may CHOOSE to take advantage of the opportunity there or let it go. Watch for these opportunities.

Your must LAND IN a space to pick up a Hazard card, read it aloud and follow its directions.

D. Object of the Game: When reaching STOP you want to make sure you have no waste and as much money as possible. To earn money you must pick up and dispose of hazardous wastes of your choice. You may dispose of wastes properly for a fee or dispose of them improperly for free but run

the risk of getting caught by the board, a Hazard card, or an opponent.

E. Pick-up Options: When landing in or passing over a pick up option you have the opportunity to pick up one ton of the specified waste. If you decide to pick up the waste, the banker will give you the appropriate Waste card along with the specified payment for delivery. You will read the card aloud, take note of the needed disposal site and retain the card until the waste is disposed of.

F. Disposal Options: When landing in or passing over a disposal option you have the opportunity to dispose of any or all wastes you hold if the disposal method is approved of on the Waste card. Should you decide to dispose of waste, you return the Waste card with the specified payment to the banker. If you elect safe disposal, you need only read the appropriate Disposal Card aloud and return it to the banker. You have the choice of paying for proper disposal or dumping the waste improperly free of charge. If you elect to go "midnight dumping" the banker will give you an Unsafe Disposal card which you read aloud and retain throughout the game.

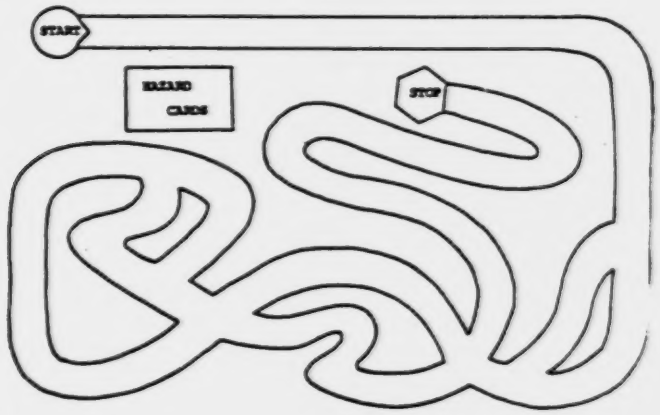
G. Investigation: When landing in a black space, you may choose any opponent holding an Unsafe Disposal card and take him to court. His sentence is to be determined by you. You fine him $5,000 payable to the bank or send him back ten spaces. Collect a $200 reward.

H. STOP: You must land exactly in the STOP space. All waste must be disposed of through the final Deep Well Injection disposal option. The first player to reach STOP collects a $2500 bonus. When all players reach STOP, their money is counted and whoever has the most is the winner.

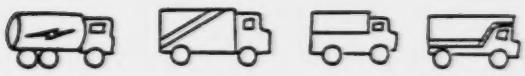
HAZARD

Gameboard Construction

Duplicate the gameborad pieces on pages 111-115, trim the edges and tape together or glue on posterboard to construct a board like this:

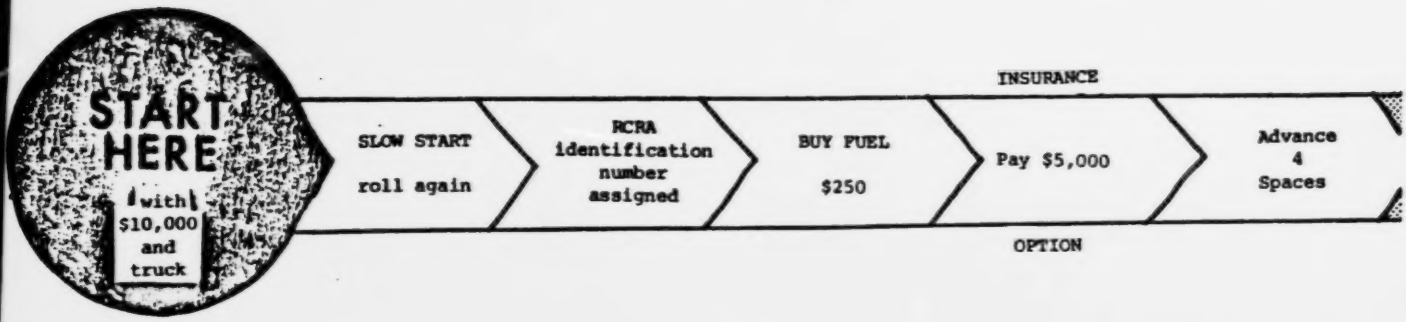


Glue the rest of this page on cardboard and cut out the place markers and insurance cards below.

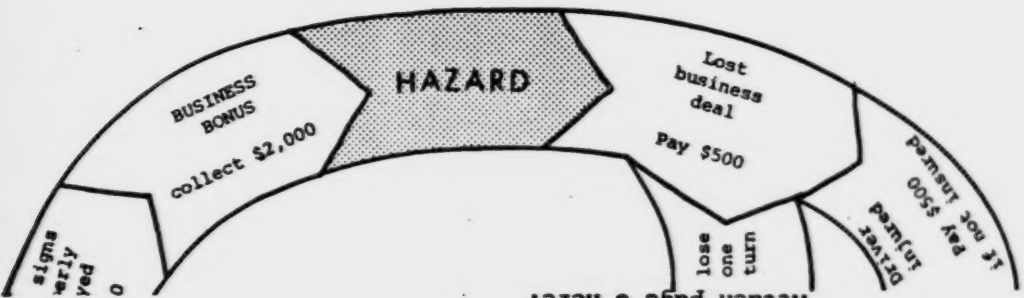


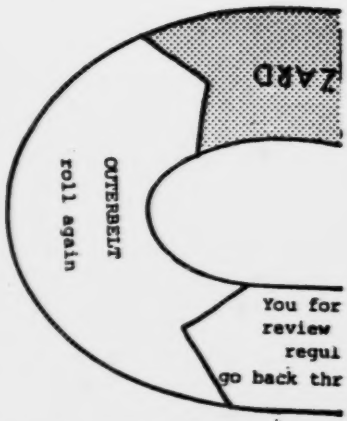
INSURED	INSURED
INSURED	INSURED

Glue the rest of this page on cardboard and cut out the place markers and insurance cards below.



HAZARD CARDS





Attach page 112 here

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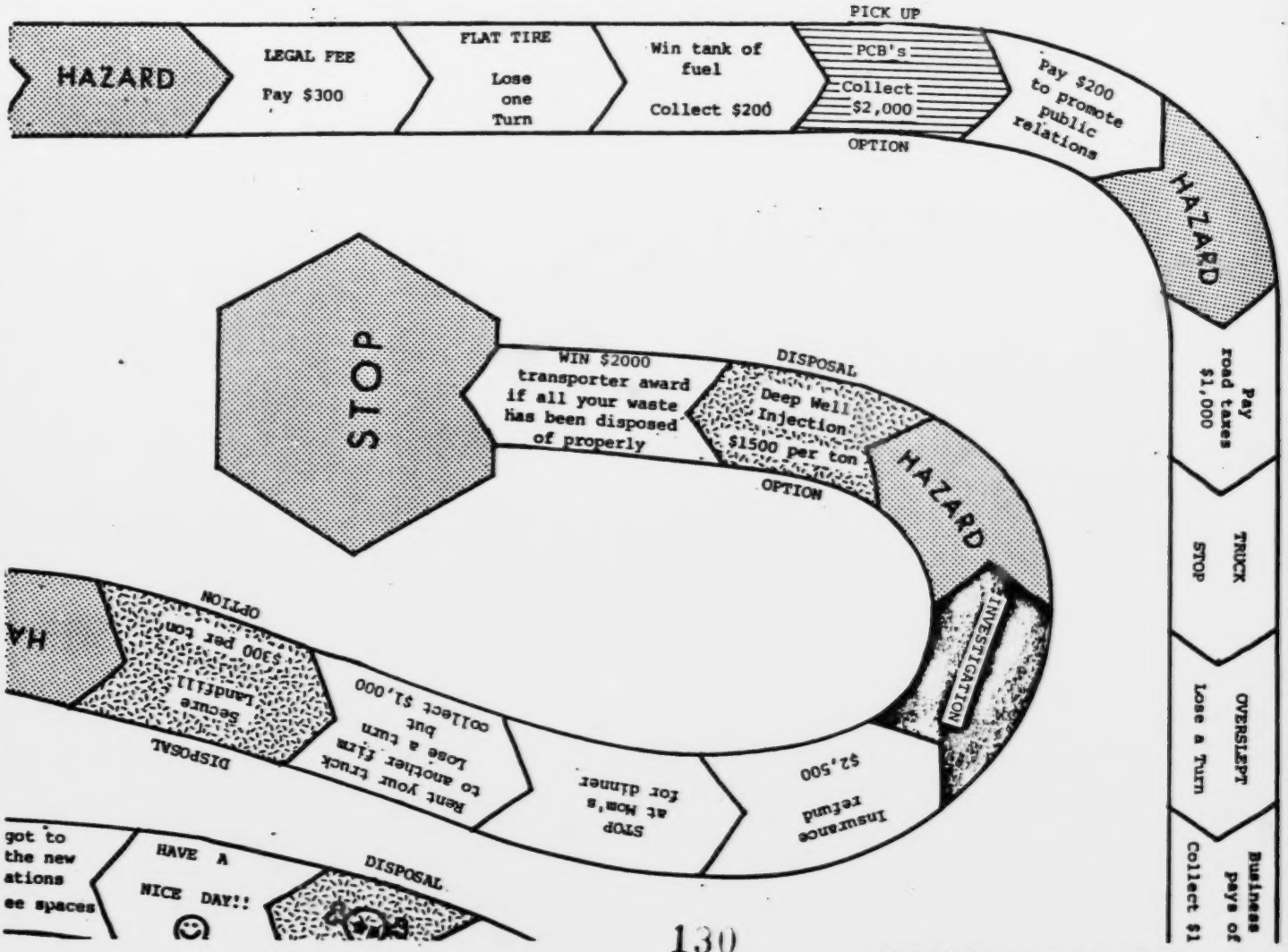
Attach page 111 here



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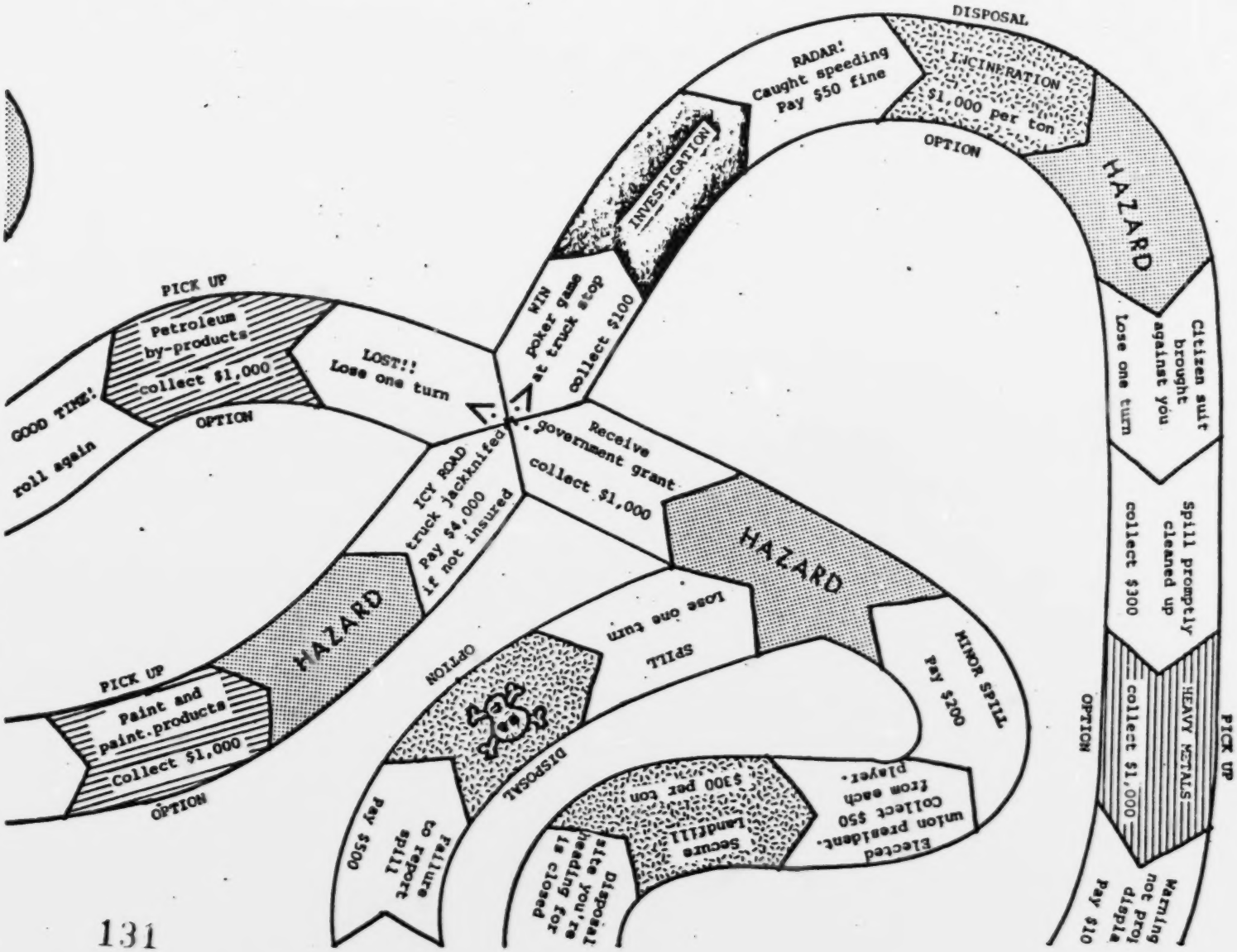

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113

131

132

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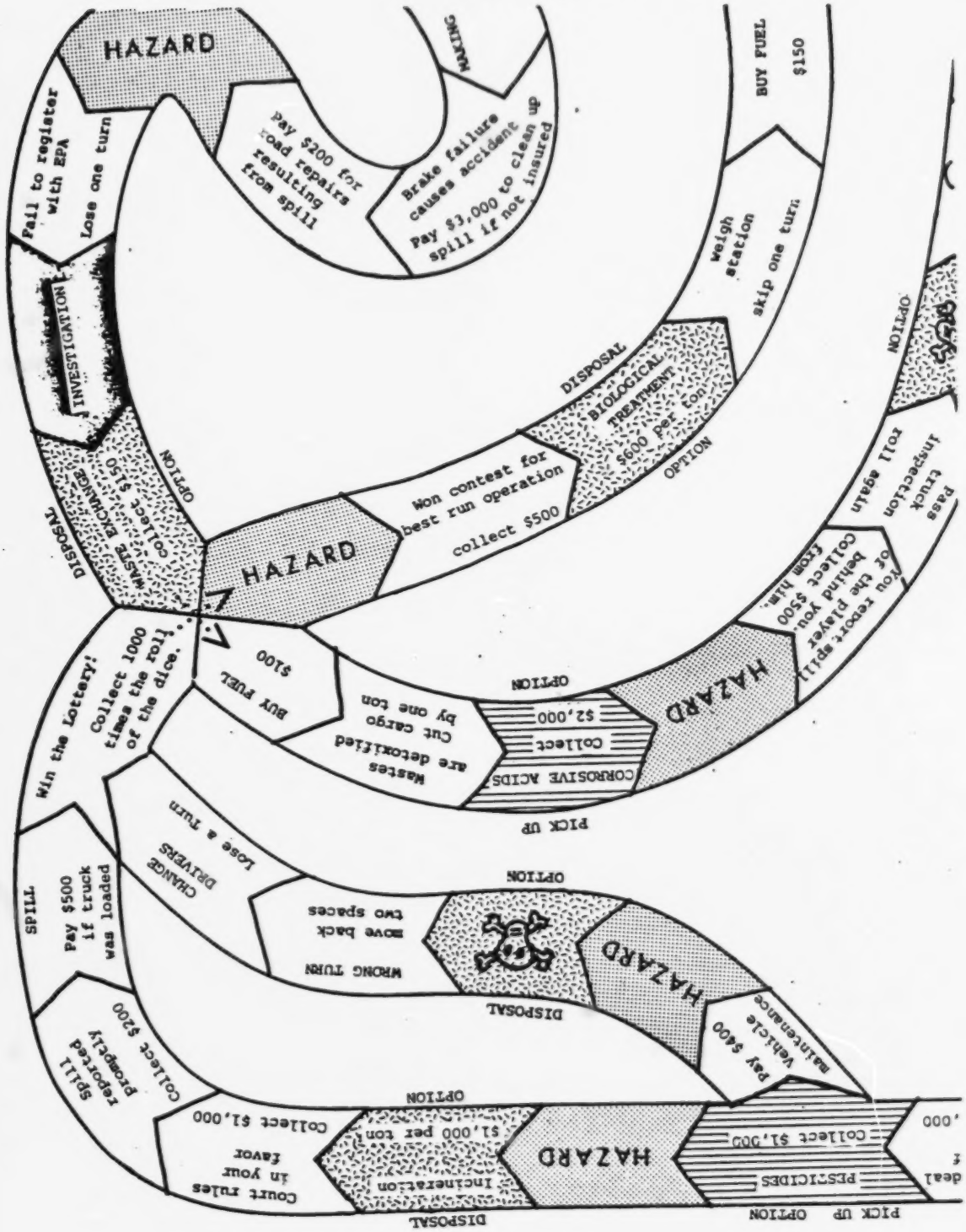

HAZARD CARDS

(One copy per game - pink)

Ohio's present disposal capacity falls 4-7 tons short of what is necessary to properly manage hazardous wastes. Lose turn to wait for an acceptable site.	You failed to rinse out your truck after dumping the last load. The residue reacted with other chemicals you were hauling and an explosion occurred. If you have insurance you lose your policy. If uninsured pay $3,000.
The U.S. Department of Transportation requires you to attend a training session to learn more about the chemistry of various wastes. Skip a turn but collect $100 reimbursement.	You inhaled some poisonous gas while filling a tank truck, and must visit a hospital for treatment. If uninsured pay $200.
Ground water in a 30 square mile area near Denver was contaminated from disposal of pesticide waste in unlined disposal ponds. The dumping took place from 1943-1957. Decontamination, if possible, could take several years and cost as much as $80 million. Contribute $100 to help.	You used some dangerous pesticides in your back yard which washed into a nearby stream. Your dog is sick from playing in the stream. Pay $50 vet bill.
You convince your company to sell some heavy metals to a waste exchange for recycling. Recycling is one of the best solutions to our hazardous waste problem. Roll again.	The health of some residents of Love Canal, near Niagara Falls, was seriously damaged by chemical waste buried a quarter of a century ago. You volunteer to help evacuate residents. Lose a turn.

HAZARD CARDS

(One copy per game - pink)

You took a day off to attend an EPA conference on hazardous wastes. Because of your attendance you know more about our hazardous waste problem. Receive a $100 bonus from your boss.	You were hauling corrosive acids when you wrecked your truck on a country road. If uninsured pay $3000 to clean up the spill.
An increase in the use of plastics has caused an overabundance of petroleum by-products. Your company insists on safe disposal. Collect $300.	At a town meeting you tried to convince people that they should allow a new secure landfill to be built near the town to help end "midnight dumping." Take another turn.
If you have improperly disposed of a waste, the EPA has caught up with you. Pay $5000 fine and go back 10 spaces.	You were careless at a railroad crossing. A train hit your truck and toxic chemicals were spilled. If you have insurance pay nothing, but lose your policy. If uninsured, pay $2500.
If you have improperly disposed of a waste, the EPA has caught up with you. Pay $5000 fine and go back 10 spaces.	You are hauling wastes for a company which uses only safe secure landfills for disposal of paint by-products. Currently, only 10% of the hazardous wastes generated in this country are disposed of properly. Roll again.

HAZARD CARDS

(One copy per game - pink)

You visit a high school to teach students about our hazardous waste problem. Lose a turn but receive $100 for your services.	You've lost the manifest which the Resource Conservation and Recovery Act requires for all transported hazardous wastes. Lose one turn.
A fellow truck driver was asphyxiated by hydrogen sulfide produced when discharged liquid wastes mixed in an open pit. Lose one turn to pay your respects.	Petroleum by-products were discharged from an industry into a river. The river caught fire and burned a bridge you need to cross. Lose a turn.
If you have improperly disposed of a waste, the EPA has caught up with you. Pay $5000 fine and go back 10 spaces.	Attend a hazardous waste conference for homemakers. Learn that substances such as nail polish, household cleaners, and antifreeze become hazardous wastes if improperly disposed of. Collect bonus of $50 times roll.
Your uncle stocked up on chlordane before it was banned and you convinced him to stop using it and dispose of it in a proper manner. Take another turn.	You carelessly left a can of varnish stripper near the furnace in your basement and it started a fire. Pay $1000 for damages to your home.

WASTE CARDS

(Four copies per game - blue)

PCB's are found in heat transfers of electric transformers and capacitors, paints, inks, adhesives, and hydraulic fluids. Bioaccumulation through the food chain concentrates PCB's in the fatty tissues of mammals causing reproductive failures, gastric disorders, skin lesions and tumors. PCB's may be disposed of safely by incineration.	Organochlorine pesticides, many of which have been banned, bio-accumulate in humans, fish and wildlife more than other chemical compounds and can cause cancer. Examples include DDT, chlordane, and dieldrin. Pesticides are disposed of through biological treatment.
Oil emulsion, a by-product of oil refining, is ignitable or explosive if exposed to heat, which can result in human death or injuries. Deep well injection or secure landfill may be used to dispose of petroleum and oil wastes.	A corrosive acid is one which has a pH of 2.0 or less or is capable of corroding steel at a rate greater than 1/4 inch per year. Corrosive acids are generated in the production of petroleum products and metals. In Ohio alone, over 42,000 tons of acids are generated by industries each year. Corrosive acid may be deep well injected for disposal.
Paint, used solvent, latex sludge, varnish remover, and paint stripper are all ignitable if heated and may cause accidental human injury or death. Paint and paint products can be deep well injected or placed in a secure landfill.	Hazardous heavy metal wastes include mercury (batteries, paints and industrial instruments), lead (gasoline, paints, pipes, and roofing materials), arsenic (pesticides, smelters, and glass production), and cadmium (fossil fuels, fertilizers, and zinc refining). Mercury and lead can damage the human brain and nervous system. The others cause various toxic effects of man and wildlife. Heavy metals may be incinerated, placed in a secure land-fill, or recycled through waste exchange.

BEST COPY AVAILABLE

DISPOSAL CARDS

(Four copies per game - blue)

Biological processes can be used to make a hazardous waste less of a hazard. These include activated sludge treatment to destroy organic compounds, composting of organic rich wastes, filters to promote decomposition, and controlled application on land to degrade organic compounds.	Certain liquid wastes can be safely disposed of by deep well injection. Wastes are pumped into rock formations, thousands of feet underground, which are separated from water and minerals by impermeable layers of rock. Deep well injection is the most expensive disposal method available.
A secure landfill is suitable for the disposal of both liquid and solid hazardous wastes. The waste is contained in drums and is buried in cells. These cells contain monitoring and drainage systems, are lined with heavy plastic liners, and are surrounded by at least five feet of impermeable clay. The development of secure landfills is more difficult than incinerators or deep wells because of strict siting requirements.	Incineration is a highly controlled process that uses high temperature combustion to totally destroy hazardous wastes or convert them to to safer substances. Nearly all types of toxic wastes can be disposed of by incineration. It is particularly good for disposal of PCB's.
Hazardous wastes from one industry are sometimes valuable resources for another. Recycling to recover reusable materials makes good economic and environmental sense. About 9% of all industrial wastes can be recycled. Only 20% of this amount is actually recycled.	The cheapest alternative for disposal of hazardous wastes is "midnight dumping." With a truck and a total disregard for public safety, midnight dumpers can dispose of wastes cheaply by flushing it into sewers, dumping it into lakes and rivers, dumping it at sea, concealing it in municipal waste for disposal in sanitary landfills, or dumping it on private land.

(30 copies per game - green)

ODOR POLLUTION

PURPOSE: To recognize the potential impacts and hazards created by odor pollution.

LEVEL: 7-9

FOCUS: Hazardous Materials in the Air

SUBJECT: Physical Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 79-80. ED 263 015.

BACKGROUND: Consider introducing the students to the classification of odors. This commonly constitutes a blend of four primary smells: fragrant, acid, rancid and burnt. If the primary smells could be measured on an arbitrary scale, every odor on earth would be given a distinctive number based on the strength of its constituents. Have an example in a sealed and labeled container for fragrant and burnt odors. Use a hood if you have one available. Do not use or allow students to smell the acid or even the rancid types because of potential damage to the respiratory system.

The classroom can be used to illustrate the dilemma of the employee who is making money on the job, while also being subjected to industrial pollutants in much greater concentrations than those found outside the workplace.

ACTIVITY 1: Provide the students with a handout containing selections from the questions below or questions relating to lead. Previously saturate the paper with some perfume; several drops should be sufficient in the upper right hand corner. For use of this "unknowingly contaminated paper," refer to the selection below title, "Next Class Meeting" (p. 123).

Consider the following set of experiments. Provide the students at each table with a set of 10 test tubes containing various dilutions of perfume in water. These should vary from levels that are non-detectable to some samples containing the pure material. Be sure to include a sample of pure water, your dilution material, as a control. It may be necessary to substantially dilute these mixtures. It is recommended that they be in the screw cap type of test tube. Instruct students to test for odors by holding an uncapped test tube 18 inches

from the nose and using a slow waving motion with the hand to circulate the odors toward the nostrils. Since these tubes are numbered, each student should record the number on the tube which they can or cannot detect the odor. Essentially they have determined their own olfactory threshold for this perfume or cologne.

A variation of the above experiment would be to determine which cologne is the one of preference. In this case, simply have a series of unlabeled test tubes containing various perfumes or after-shave lotions. Each student would be asked to rank the samples from most pleasing to least pleasing. You might ask them what their basis for selection was.

Continue to remind the students to recap their test tubes, so they can be used by other classes during the day.

ACTIVITY 2: Explain to the students that the classroom represents the factory, and they are to be the employees. They are engaged in work which they enjoy and are earning an above average salary. Allow them to suggest what this hourly rate might be.

The salary is earned only when they work.

At this time, send two students on an errand or a library research project for 10 minutes. With the door and any windows closed, the teacher should circulate around the room spraying an atomizer of inexpensive perfume into the air above the students. Initially the odor should be slight and not too offensive -- perhaps even pleasant to some, since it represents the profits all are producing. As the teacher continues to walk around the room spraying the scent, use the following questions to elicit discussion:

1. In a factory, what do the odors of raw materials or products represent to the employees?

2. We identify odors as pleasant or unpleasant. Can we also base our opinions on what is good for you or bad for you? How can one determine if an odor is hazardous to you?

3. What other factor needs to be considered about the odor? (concentration)

4. Is the odor scenting the air around me diffusing from a source? How does diffusion work? Is it temperature related?

5. Can this perfume hurt my clothes? My hair? Would it be dangerous if I swallowed it with my food?

If we continue long enough, the olfactory receptors in our nose will become over worked, and we will become used to the smell or stop noticing it. This is often known as olfactory acclimation. About this time, the two students sent on an errand should return and be questioned about their impression of the odor level of the perfume in the room. The teacher should also review for them the happenings while they were out of the class.

The recover time for olfactory detection of the odor can be measured by sending pairs of students outside and returning at specific time intervals ranging from 1 to 10 minutes. During this testing, the teacher may find it necessary to continue spraying the perfume. Since individuals differ, possibly larger groups may be needed for better results. The teacher may want to keep a running record of the data from class to class and year to year.

Additional Questions:

1. Are all obnoxious odors unsafe?
2. What is OSHA and how does it function?
3. Define diffusion.
4. How are odors produced?
5. What eventually happens to odors?
6. List several occupations where odors are encountered.
7. Comment on the lead level in the blood of Toll Road Collectors.
8. Does a lead pencil contain lead? (graphite)
9. How do we smell?
10. Do all animals have olfactory organs?

Next Class Meeting:

After reviewing or checking on the questions asked on the handout sheet secretly contaminated above in the "Group Activity" section, break the news that their paper had some perfume placed on it purposely by you. Confirm this by asking them to check for the odor on a specific place on the paper. This represents a spill in the factory and the paper represents their clothes or any other item they took home from work. You ask them to trace the spread of the odor or contamination by listing where it was used and stored. Such as using the kitchen table, desk, bed .... as the site to complete the questions.

Requiring this as a parent-signed homework assignment should help assure that it has some travel exposure. The teacher should continue to impress upon the students how simple it is to spread contamination.

AIR POLLUTION

PURPOSE: To identify major sources and types of air pollution.

LEVEL: 7-9

FOCUS: Hazardous Materials in the Air

SUBJECTS: Health
Science

CONCEPTS: Pollutants and contaminants are produced by natural and man-made processes.

Increasing human population, higher standards of living, and resultant demands for greater industrial production promote increasing environmental contamination.

REFERENCE: Zamm, Michael and Denise Hurtado. Training Student Organizers Curriculum. New York, NY: Council on the Environment of New York City, 1983, pp. 24-26. ED 226 988.

BACKGROUND: Air pollution can come from dust storms, tree pollen, fires, and volcanic action. Most urban air pollution, however, comes from man-made sources -- automobiles, industry, and electric power plants. In the United States, mobile sources such as cars and trucks discharge 50-60% by weight of all airborne emissions. In many cities, the most significant source of air pollution is the internal combustion engine! Motor vehicles are responsible for roughly 75% of the carbon monoxide, 60% of the hydrocarbons, and 40% of the nitrogen oxides in the U.S. The continued burning at the present level of oil, gas, coal, and other fossil fuels ensures a continuous and significant level of air pollution in the U.S., at least for the near future.

The main air pollutants are carbon monoxide, sulfur dioxide, nitrogen oxides, ozone, particulates, and hydrocarbons. These pollutants irritate the eyes and nose, erode buildings, and threaten human health. While there are controversies over the extent and effects of air pollution on health, researchers have found a statistical relationship between air pollution and mortality.

Yet air pollution control is a controversial issue. Clean air standards affect land-use, economic growth, industrial location, and transportation modes, and vice versa. Industries and power companies feel that air standards restrict growth. Less pollution regulation would result in a more prosperous economy and in the use of a cheaper, more abundant fuel source such as coal or high-sulfur oil.

Environmentalists point out some of the real costs of polluted air -- hospital visits, illness-related work absence, poor health.

Discussion:

a. Do you think most of our urban air pollution comes from natural or man-made sources?
b. What are the major man-made sources of air pollution?
   - o Motor vehicles, e.g., cars, buses, taxis, trucks.
   - o Power plants and industrial facilities which burn oil and coal with inadequate emissions control devices.
c. What are some naturally caused pollutants?
   - o Dust storms.
   - o Tree pollen.
   - o Fires.
   - o Volcanic action.
d. What are the main air pollutants in the U.S. and what are their major sources?

Table 1. Estimated pollutant emissions in the United States 1970 through 1977 (millions of metric tons)

Year	Suspended Particles		Sulfur Oxides		Nitrogen Oxides		Hydro-carbons*		Carbon Monoxide		Total
1970	22.2	11%	29.8	15%	19.6	9%	29.5	15%	102.2	50%	203.3
1971	20.9	10%	28.3	14%	20.2	10%	29.1	15%	102.5	51%	201.0
1972	19.6	10%	29.6	14%	21.6	11%	29.6	14%	103.8	51%	204.2
1973	19.2	10%	30.2	14%	22.3	11%	29.7	14%	103.5	51%	204.9
1974	17.0	9%	28.4	15%	21.7	11%	28.6	15%	99.7	50%	195.4
1975	13.7	7%	26.1	14%	21.0	11%	26.9	15%	96.9	53%	184.6
1976	13.2	7%	27.2	14%	22.8	11%	28.7	15%	102.9	53%	193.8
1977	12.4	6%	27.4	14%	23.1	12%	28.3	15%	102.7	53%	193.9

* Volatile hydrocarbons only; methane and other nonreactive compounds omitted so far as possible.

National Air Quality Monitoring and Emission Trends Report, 1977 EPA, December 1978.

Table 2. Estimated pollutant emissions by source, 1977
(millions of metric tons)

Source	Suspended Particles		Sulfur Oxides		Nitrogen Oxides		Volatile Hydro-carbons		Carbon Monoxide	
Transportation (autos, trucks)	1.1	9%	0.8	3%	9.2	40%	11.5	41%	85.7	83%
Combustion (power, heating)	4.8	39%	22.4	82%	13.0	56%	1.5	5%	1.2	1%
Industrial processes	5.4	43%	4.2	15%	0.7	4%	10.1	36%	8.3	8%
Solid Waste (incinerators)	0.4	3%			0.1		0.7	2%	2.6	3%
Miscellaneous (fires, solvents)	0.7	6%			0.1		4.5	16%	4.9	5%
Total	12.4		27.4		23.1		28.3		102.7	

National Air Quality Monitoring and Emissions Trends Report, 1977 EPA, December 1978

Photo-chemical oxidants, of which ozone is a major example, are formed from the interaction of nitrogen oxides and hydrocarbons. The principal sources for both are motor vehicles. Since photochemical oxidants are secondary pollutants stemming from interactions of two of the primary pollutants listed, no percentages are included for them.

The pollutants listed here are gases which concentrate in our atmosphere at a certain height above street level. Non-gaseous pollutants like lead which concentrate at levels below the roof top settings of most air pollution monitoring devices are not included, yet can be extremely detrimental to human health.

e. What is the most prevalent pollutant in the U.S.?
   o Carbon monoxide is dangerous to health and is the most prevalent pollutant in the atmosphere, making up over 50% of the nation's pollution.

ACTIVITY:

1) Ask a committee of students to research each major pollutant to find out its chemical characteristics and health effects.

2) Ask another group to devise strategies for lowering pollution levels, e.g., car pooling or increased use of mass transit to reduce automobile use; using emission controls on conventional power plants, etc.

AEROSOL SPRAYS

PURPOSE: To identify the impact of aerosol sprays on the environment.

LEVEL: 7-9

FOCUS: Hazardous Materials in the Air

SUBJECTS: Science
Language Arts

CONCEPTS: Pollutants and contaminants are produced by natural and man-made processes.

Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Mann, Lori and William B. Stapp. Thinking Globally and Acting Locally: Environmental Education Teaching Activities. Columbus, OH: ERIC/SMEAC, 1982, pp. 136-137. ED 229 214.

ACTIVITY:

1. Distribute copies of the report, "Canadian Government to Phase Out Use of Fluorocarbons" (page 128).

2. Ask students to research and write papers in response to the report. Papers should include reactions to the following questions:

   a. What positive impacts might Canada's actions have on the world environment?

   b. Has the United States limited use of fluorocarbons? Have other countries besides Canada? Should other countries?

   c. What are some other natural or human-induced changes in the stratosphere that might affect weather, climate, agriculture and human health?

   d. What percentage of the fluorocarbons emitted to the atmosphere are produced by the United States?

   e. Do you use aerosol products? How many of the products you use could be used without aerosols? What are some of the alternatives facing you? What actions are you willing to take to reduce your use of aerosols? What actions might be taken in your community?

CANADIAN GOVERNMENT TO PHASE OUT FLUOROCARBONS

Fisheries and Environment Minister Romeo LeBlanc announced on 15 December 1976 that the Federal Government will move immediately to phase out the use of fluorocarbons F 11 and F 12 in Canada. Regulations to be developed under the Environmental Contaminants Act would require the elimination of all non-essential use of F 11 and F 12 in aerosol products during 1978.

A report by the AES Advisory Committee on Stratospheric Pollution indicates that there is little question about the fundamental aspects of the problem and that the continued release of fluorocarbons does indeed present a threat to the earth's ozone shield. Among the consequences of continuous release would be:

1. an effect on the climate although the magnitude of the effect is uncertain;
2. an increase in the incidence of skin cancer;
3. an effect on plants and animals which cannot be protected from harmful ultra-violet radiation; and
4. possible changes in ecosystems.

Ozone is found in the stratosphere. The stratosphere begins at the height of about 16 km above the surface in the tropics and at about 8 km near the poles. Depletion of ozone will result in alteration of the temperature in the stratosphere with possible effects on surface temperatures. Because of its geographic location, Canada is more susceptible to climatic effects and less affected by increases in skin cancer than countries located farther south.

The report calls for Canada to take part in international efforts in the field of research, education and preventative regulations related to the protection of the ozone shield and recommends an increase in research and monitoring effort. It further recommends that the government be prepared to re-examine the problem periodically as new information becomes available and to alter any regulations accordingly.

"Action has already been taken," Mr. LeBlanc said. "As a result of discussions with departmental officials, the aerosol industry has agreed to reduce by one-half the use of fluorocarbons by the end of 1977. Industry will be required to submit progress reports quarterly and consideration is also being given to clearly labeling aerosol packages which contain fluorocarbons F 11 and F 12."

The Minister stressed that it should be made clear that not all aerosol sprays on the market will be affected. Only spray

products which use F 11 and F 12 as propellants - hair sprays, deodorants and antiperspirants - will be phased out. Other spray products such as shaving creams, whipping creams and most spray paints use other propellants and are not affected.

It should be noted that Canada produces only 2 per cent of the fluorocarbons emitted to the atmosphere. The Minister stressed that Canada will continue to show leadership by taking measures to limit the release of F 11 and F 12 within Canada but emphasized that further steps toward prohibition must coincide with North American and indeed global action.

Source: News Release (15 December 1977)
Dr. Jim Brydon
Environmental Protection Service
Environment Canada
Ottawa, Canada

HEALTH EFFECTS OF AIR POLLUTION

PURPOSE: To identify the harmful health and property effects of air pollution.

LEVEL: 7-9

FOCUS: Hazardous Materials in the Air

SUBJECTS: Health
Science

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Alaska Department of Environmental Conservation. Clean Air for Anchorage and Fairbanks, Curriculum for Grades 7-12. Juneau: South East Regional Resource Center, February 1980, pp. 15-16. ED 212 461.

ACTIVITY: The hazards to human health from air pollution have been well documented during the past two decades. It is generally true of air pollutants that unless the pollutant is evident in massive amounts, illness and disease are not immediate results. The long-term nature of pollution-related health problems is an important aspect which obscures the dangers.

Inform students that they will be expected to write a story which will take place in an environment of dangerously polluted air. Provide the list of words below as examples of vocabulary terms which they may wish to incorporate into their stories:

emission	sulfur	carbon	asthma
pollutant	sulfur oxide	carbon dioxide	emphysema
gas	nitrogen	resistance	anemia
oxygen	nitrogen oxide	irritation	fatal
oxide	particulate	bronchitis	

The teacher may wish to suggest the following as examples of appropriate titles:

The Killer Fog
How I Saved the World from Air Pollution
The Day the Sky Turned Brown
We Have to Move to the Moon
How the Space People Saved the World

Some students may wish to write and produce a play on air pollution, using the general framework suggested above.

ACID RAIN'S EFFECTS ON BUILDINGS -- A RESEARCH PROJECT

PURPOSE: To investigate how acid damages buildings and monuments.

LEVEL: 7-9

FOCUS: Hazardous Materials in the Air

SUBJECT: Science

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Minnesota Sea Grant Program. Aquatic Activities for Middle School Children: A Focus on the Effects of Acid Precipitation. Minneapolis: University of Minnesota, 1982, p. 62. ED 223 436.

ACTIVITY: As a research project, investigate the damage done by acid rain to buildings and monuments. There have been a number of articles about the damage that is being done to the ancient temples in Rome and Greece, as well as to buildings in New York and London, among other locations.

LEACHATES AND WATER SUPPLIES

PURPOSE: To increase awareness of problems associated with leachates.

LEVEL: 7-9

FOCUS: Hazardous Materials in the Water

SUBJECT: Science

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, p. 37. ED 254 443.

ACTIVITY: The following reading discusses different ways in which toxic wastes can be treated or properly disposed of. If not taken care of by one of these methods, the material often becomes a leachate which then contaminates groundwater.

Almost half of the United States's water supply comes from groundwater, and in some communities, particularly rural ones, population is almost totally dependent on it. Groundwater is also formed by precipitation percolating through the soil into the rock layers below. There, it fills any available spaces and flows through cracks. Groundwater can end up miles from where it was formed. Sometimes groundwater feeds lakes and rivers, and sometimes these bodies of water feed groundwater. Therefore, contamination of groundwater, rivers, lakes, or marshes can eventually pollute the water supply.

When reading about the available methods of treatment, consider the following estimates on the cost of new treatment facilities (1979 statistics):

Physical/Chemical/Biological Treatment----------$2-5 million
Incineration----------$10-20 million
Secure Landfill----------$2-5 million
Deep-well Injection----------$2-3 million
(from National Solid Wastes Management Assn.)

After completing the above reading, answer the following questions:

1. What are the drawbacks of each method?

2. What the advantages of each method?

3. Would you be willing to have any of the treatment facilities in your community? Why?

4. Would you be willing to live next to any of the treatment facilities? Why?

BIOMAGNIFICATION OF TOXIC MATERIALS

PURPOSE: To trace the path of a hazardous substance through a food chain.

LEVEL: 7-9

FOCUS: Biological Aspects

SUBJECTS: Life Science
Environmental Science

CONCEPTS: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFEPENCE: Vivian, V. Eugene, et al. Solid Waste/Energy Curriculum. Whitesbog, NJ: Conservation and Environmental Studies Center, 1983, pp. 294-295. ED 237 355.

BACKGROUND: Some hazardous wastes burn and explode. Others pollute water and air supplies. Most of them can either damage or kill living organisms.

In small amounts, they may have little effect. However, nature's food chains can collect some of these substances and produce large concentrations of them in living organisms. This is known as biomagnification.

Definitions: biomagnification - All plants and animals have the ability to concentrate some of the substances contained in their food or drinking water. Some substances are increasingly concentrated as they pass upward in a food chain.

food chain - Plant-feeding animals (herbivores) are eaten by other animals (carnivores). Some carnivores are themselves eaten, by other carnivores. The series of living things which feed upon one another is called a food chain.

ppb - an abbreviation for parts per billion.

ACTIVITY: Read the following hypothetical example of the biomagnification of DDT. The insecticide DDT is now banned in the United States. It and many other similar substances often become hazardous wastes.

Imagine that you have a very serious insect problem in your cornfield and you decide to use DDT to control it. You spray your fields once at about 9 a.m. Immediately

you test the water of a small stream nearby for signs of DDT. You find 0.01 ppb, a very small concentration. Thirty minutes later, you test again and find 0.00 ppb. What happened to the DDT? Did it wash downstream? Did it dissolve or decompose in the water?

You find your answer when you test the bodies of various organisms found in the stream community.

Close to the bottom of the food chain, stone fly larvae collect DDT by eating plankton and other small organisms.

Minnows feed on fly larvae and many other small invertebrates of the stream community.

Trout feed not only on fly and mosquito larvae, but also on small fish like the minnows. It doesn't take much time for trout to concentrate DDT in their tissues.

The kingfisher feeds on fish, reptiles, large insects, small mammals, and birds, all of which already have significant concentrations of DDT in their tissues.

At the top of the food chain, the hawk has the highest concentration of DDT. One physical effect is a decrease in eggshell thickness; the hawk's eggs are weak, and tend to break very easily. This prevents successful reproduction of the species.

How is DDT accumulated in these organisms? The main reason is that there are no natural means by which DDT is broken down, or decomposed; it is not biodegradable. Due to its chemical composition, it is stored in the fatty tissues of organisms and is not excreted by their bodies.

Trace the concentration of another introduced environmental pollutant such as lead from gasoline.

Below are lists of hazardous substances and different environments. Select one substance and one environment, and locate information about them.

Hazardous Substance	Environment
PCB	forest
mercury	pond
lead	ocean
cadmium	marsh
other pesticides	desert

Draw a food chain, or pyramid, based on the information above. Identify the relationships between the organisms in the

selected environment. This information can be found in biology texts and in ecology books in the library. Information on hazardous substances can be found in many sources. Ask your librarian for help. When you have completed your drawing, present and explain it to your class.

PESTICIDES

PURPOSE: To evaluate the benefits and hazards associated with pest control.

LEVEL: 7-9

FOCUS: Biological Aspects

SUBJECTS: Health
Science
Social Studies

CONCEPTS: Pollutants and contaminants are produced by natural and man-made processes.

Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Mann, Lori and William B. Stapp. Thinking Globally and Acting Locally: Environmental Education Teaching Activities. Columbus, OH: ERIC/SMEAC, 1982, pp. 132-135. ED 229 214.

ACTIVITY: Distribute copies of the handout (Shall We Spray?, p. 140) and ask students to read and respond to the situation.

After students are familiar with the situation described divide the class into four groups: the first will advocate the use of DDT; the second will oppose its use; the third will represent a hypothetical International Commission for the Protection of the World Environment; and the fourth will represent the United States Environmental Protection Agency.

The first three groups will research and prepare testimony to be heard by the EPA panel. The panel will decide if the situation warrants issuing an emergency permit for the use of DDT, in accordance with the 1972 regulations banning the chemical. A time limit of 10 minutes should be placed on each prepared testimony.

Students preparing for the hearing should consider:

1. The economic implications and long-range environmental impact of granting or not granting the permit.

2. Alternatives or compromise solutions to the problem.

3. The EPA criteria which must be met before the use permit can be approved. (Students role-playing the EPA should research and establish these.)

The students representing the EPA should familiarize themselves with the 1972 EPA regulations on the use of DDT, as well as any additional amending regulations.

In their search for alternatives and solid criteria, students should be encouraged to consult current references.

VARIATION:

Hold a class discussion on these questions:

1. What can these people do to solve their problem? What are their choices? Do either have alternatives available they have not expressed? If so, what are they?

2. How would you resolve this dilemma? What information do you need before making your decision? On what criteria would you base your judgment? What legal constraints and procedures must be considered?

3. Is there something about the quality of oranges that we could perhaps deal with? Would this be a help?

4. What world impacts need to be considered in making a decision to solve this problem?

NOTE:

While the dialogue represents a hypothetical situation, the data regarding the effects of DDT on salmon runs reflect the results of actual research. For a review of actual case histories see:

Rudd, Robert L., Pesticides and the Living Landscape (Madison, Wisconsin: University of Wisconsin Press, 1966), pp. 106-109.

SHALL WE SPRAY?

"Those pesky insects have to be stopped before they destroy the whole citrus crop. Whenever one of those bugs bites into an orange, it leaves a spot--doesn't hurt the fruit a bit--but it marks the skin and people just won't buy a spotted orange. If we don't get in there and spray soon we will lose the crop," stormed the farmer.

"I understand your problem," replied Bob Hartley, the local Wildlife Manager. "But you can't use the poisons you have in mind. I know they are very effective in protecting your oranges, but they are persistent and carry throughout the ecosystem. They destroy the predaceous insects, lizards, and amphibians who eat lots of insects, and we have a lot of different kinds of birds nesting and feeding in the citrus groves. When they eat insects that have died of your poison--and one bird may eat hundreds in a single day--the birds get a terribly heavy shot of the same stuff. If it doesn't kill them directly, it sooner or later affects them via the thinning of egg shells, weakening of newly-hatched birds, or malfunctions. And when we lose the birds, the predatory insects, and these other insectivores, we <u>really</u> get an explosion of insect life--not just in the citrus grove--but in the whole neighborhood."

"But this is the only stuff that works fast enough, and hits hard enough, to do the job," The farmer explained. "When those bugs hatch, we are in trouble right away. I sure don't want to bother those birds, or those other critters either--but dang--my livelihood depends on this fruit being top quality. If I don't spray, my kids don't eat."

VERMICULITE - A RESEARCH PROJECT

PURPOSE: To identify the potential problems associated with contamination of vermiculite.

LEVEL: 7-9

FOCUS: General Aspects

SUBJECTS: Science
Health

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 95-97. ED 263 015.

ACTIVITY: Vermiculite is a light-weight, free-flowing, non-combustible substance which is chemically inert, insoluble, resilient, and non-abrasive. It is used to insulate, fireproof, extend, lighten, and aerate products ranging from potting soil to concrete, plaster board to kitty litter. But it is often contaminated with asbestos, a known carcinogen.

Develop a research project concerning vermiculite. Consider these questions: How long has vermiculite been mined in the United States? When was the first occupational standard on asbestos set? When were health problems noted in vermiculite workers? What were some of the symptoms? What is the threshold level of asbestos below which exposure causes no effect? Are products with vermiculite labeled as containing asbestos? How many people use lawn and garden fertilizers containing vermiculite each year in the United States? What regulatory options are available to control the sale of vermiculite? What could be substituted for vermiculite if it were not available?

PESTICIDES IN THE SCHOOL

PURPOSE: To identify the pesticides used in the school building.

LEVEL: 7-9

FOCUS: Biological Aspects

SUBJECTS: Life Science
Chemistry

CONCEPT: Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 107-114. ED 263 015.

BACKGROUND: Every school has had a problem with insects at some time or another. If the school serves lunches, or if students and teachers bring food from home, a constant battle must be waged against flies and roaches. Almost all students and teachers in America profess to being disgusted by the sight of insects near eating areas; however, the diseases caused by insects are seldom balanced against the hazard of improper use of insecticides. Neither is desirable. What are the alternatives? Are there any better answers?

These activities will allow students and teachers to investigate how insects are controlled in their own school and to determine what practices are applicable to this specific problem. Emphasis is on proper handling and use. Time of application and alternatives are very important considerations.

The insecticide, Kepone, formerly used in "TAT," an ant killer that was sold in a small flat can with openings for ants to enter, may be used as an example. In Hopewell, VA it got into the environment and also affected manufacturing personnel due to poor production procedures. Kepone is no longer sold or used in this country.

ACTIVITY: Announce to the students that for this activity they are going to assume the role of an advisory committee to the principal of your school. The principal would appreciate the advice and recommendations of this class on the topic of insect and pest control.

Ask the class to "brainstorm" a list of all locations inside the school building where insects have been seen. This

approach should allow students to submit ideas as soon as they originate. No negative remarks should be allowed. All suitable suggestions should be recorded on the blackboard. When the ideas come to an end, begin to rank the locations according to importance. Criteria for ranking may also be solicited from the class or may be provided by the teacher. They could include which location was mentioned most frequently, which locations had the most insects, which locations were the most offensive such as on cafeteria tables during lunch or on clean silverware.... If your school has a very heavy or a very mild infestation of insects, ranking may not be possible.

Have a set of students develop a school map. Identify the locations and attempt to rate the occurrence.

Have students interview the following staff about current methods of insect control: the cafeteria manager, the athletic director, the woodshop teacher, the science department chairman, the principal, any commercial exterminators, the custodians, the groundskeeper.... Possible questions for such interviews are:

1. Which insecticides are used in this building by you or a contractor?
2. What are the active ingredients?
3. How often is an insecticide used in your case?
4. Is the control necessary?
5. Is the insecticide effective?
6. Are any special handling precautions used?
7. When during the day or year is this treatment done?
8. Who decides that the treatment is necessary?
9. What are the alternatives to insecticide treatment?
10. Where do the insects and pests originate?
11. Is insect control a requirement of the health department or a government agency?
12. Others.....

In lieu of an interview, these resource people could be invited into the classroom to give the same information to the entire class. As noted previously, their time is quite valuable and an audio or video recording should be considered.

Most institutions and households control insects by use of one of the following agents:

BRAND NAME	ACTIVE INGREDIENTS
PT 150	pyrethrins
PT 240	boric acid powder
Ortho Pest-B-Gon Roach Bait	2% Propoxur, [-(1-methyloxy) phenyl methyl carbamate]
D-CON	0.5% Propoxur 0.237% 2-2, dichlorovinyl dimethylposphate
D-CON Double Power	0.075% pyrethrins
Ortho Earwig, Roach, & Sowbug Bait	2% Propoxur
Raid Roach Tape	4% Propoxur
Ortho Flying & Crawling Insect Spray	0.25% Resmethrin
Ortho Home Pest Killer	0.5% Diazinon
Ortho Diazinon Insect Spray	25% Diazinon (outdoors only)
Ortho Hi-Power Household Insect Fogger	0.3% Allethrin 0.19% Phenotrin

ADDITIONAL ACTIVITIES:

Student teams can determine which businesses sell pesticides and who are the major national manufacturers. They can also determine via the telephone book and advertisements, who are the commercial pesticide businesses in your area. Possibly one of your student's parents may be involved here and would be willing to come to the class to present this aspect of his business.

A student team per class could develop a list of pesticides commonly sold or used. This could include the target organism(s), the active agent(s), and any warnings on the containers.

Assign several students to become experts on the most bothersome insects or pests such as the cockroach, Japanese beetles, termites, mice, rats, bats, gypsy moths, ants, slugs, fleas, silverfish, crickets....

A student should interview the local extension agent regarding the topic of pesticides.

Ask each student to read an article on pesticides. They may want to solicit the help of the librarian and use "The Readers' Guide to Periodical Literature." Listings that may be good to pursue include: aldrin, dieldrin, chlordane, DDD, DDT, DDE, endrin, heptachlor, lindane, kepone....

MORE
ACTIVITIES: Using the interviews, student reports, guest speakers, periodical article reports, lists of pesticides, risk and benefit discussions.... conclusions need to be drawn by the class with the help of the teacher. The following questions should have been answered:

1. What is the extent of the insect and pest problem in your school?
2. By whom is the problem being addressed currently?
3. Are insecticides being used? If so, are they being used properly?
4. Are there any precautions that are not being taken which should be implemented?
5. What alternatives are available?

It is suggested that the class as a group or several teams write reports based on their recommendations.

PESTICIDES: BLESSING OR CURSE?

PURPOSE: To identify basic information from pesticide labels and to determine toxicity levels and potential hazards associated with pesticides.

LEVEL: 7-9

FOCUS: Biological Aspects

SUBJECTS: Science
Home Economics
Mathematics

CONCEPT: Increasing human population, higher standards of living, and resultant demands for greater industrial production promote increasing environmental contamination.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 153-164. ED 263 015.

BACKGROUND: Pesticides literally affect every aspect of our daily lives, from the wood used in the house, the food we eat, to the home itself and the lawns that surround the home. It can be effectively argued that pesticides have helped to raise our standard of living by providing increased production of food and timber.

This high standard of living has had its hidden price. Rachel Carson's Silent Spring explained the cost in terms of pesticides' effects on non-target species, including man. Pesticides do help control their target species, but they also affect other species and pass up the food-chain by bioconcentration. Since the publication of her book in 1962, a vigorous debate has ensued based on the risks versus the benefits of pesticides - a debate predominantly between agribusiness on the one hand and the environmentalists on the other. Each aspect of study used in this lesson will benefit by a risk/benefit analysis. The pro and con aspects should be presented for all instances.

A pesticide can be defined as any chemical used for killing insects, weeds.... This can also include animals such as rats, coyotes.... This broad definition includes insecticides and herbicides (weeds). These groups can be further divided into natural (those obtained from natural sources) and man-made (synthetic) organic compounds.

Natural pesticides were used prior to the 1940's. They were derived mainly from plants (nicotine, for example) and they broke down quite easily in the environment. Man-made organic compounds were produced on a massive scale after World War II. They are generally cyclic hydrocarbon compounds initially derived from petroleum chemistry. The most widely known (and used today, though not in the USA) is dichlorodiphenyltrichloroethane - DDT. Many more have been produced and used widely, including Clordane. These chemicals are generally long-lived in the environment. They are decomposed slowly.

A pesticide is used, as its definition implies, to control "pests." These pests include all types of insects (flying, crawling, burrowing), weeds, animals (rats, mice, coyotes), and fungi. They act by various means, killing by direct or indirect action on the target species. They can act through the skin/membrane, ingestion (poisoning), roots.... Pesticides are usually sprayed on the fields by tractor-pulled sprayers, through irrigation systems or by dusting from an aircraft.

The application of pesticides has increased drastically since World War II with the conversion of agribusiness to large scale farms based on a few crops as opposed to the predecessor family farm having small scale farming and various crops. There was more food in one place and the pest population increased (proportionately). Thus, the problem required increased use of controls such as cheap man-made pesticides. This has added massive quantities of "un-natural" chemicals to the environment (land, surface water, ground water and air).

Problems have followed this increase in the use of pesticides. Insects multiply rapidly and some species may have multiple generations in a summer. The vast numbers also guarantee a large amount of genetic variety. Thus, when fields are sprayed, many of the target species die, but some are genetically able to handle the pesticide. These few survive and breed, eventually to cause a problem again. This problem is usually handled the same way as before, by application of chemicals. The previous dosage no longer does an effective job because the target species has been "un-naturally selected." They are more resistant. This leads to an increase in dosage or the use of another pesticide and the cycle starts over again. This is an example of "forced evolution."

Pesticides tend not to be single species specific, so other insects/plants are killed also. This may allow a species formerly kept in check by natural predators to suddenly multiply and become a pest itself. Then new pesticides or dosages are needed to control the new pest.

Pesticides affect other species of plants and animals by several mechanisms. The pesticide can pass into the food chain by direct ingestion of "infested" insects or plants, or by absorption from groundwater or runoff in streams, ponds, rivers.... Because pesticides are not easily metabolized, they tend to accumulate in the tissues (bioconcentration or bioaccumulation). The effects of this can be quick, such as the poisoning of buzzards when they eat a coyote that has been controlled with compound 1080 (Sodium monofluoroacetate) or long-term, such as the decrease of bird populations due to the effects of DDT on eggs, causing them to be brittle and break before proper incubation. Sometimes, fewer eggs are laid. Also, pesticides can also affect humans. These are toxicants that can cause immediate chemical poisoning reactions when taken in large doses. Their long-term bioconcentration effects are not as well known and are currently being studied.

ACTIVITY 1: Pesticide Use Around the Home

This activity can show students how they might come in contact with pesticides in the home. It should increase their awareness of the potential problem. A survey should be made using the format suggested in the following table. The survey is a tool to help students understand how to handle pesticides safely. A cover letter like the sample appended to this lesson should be sent home explaining the purpose of the survey and asking the parents to help the students with their project. After the surveys are completed, the results can be tabulated on the blackboard or bulletin board under general categories such as a bug spray for indoors, flea powder, rose mite dust.... Also have the class discuss general safety rules and handling. Have the students list these on poster board. Suggest that these could be posted at home for ready reference. Include the number of the local Poison Control Center. This "Safe Handling" poster could also include the names of pesticides that the students listed on their survey for their homes. Please note that we are not asking or encouraging student use or handling of pesticides in this lesson.

HOME PESTICIDE SURVEY

NAME: _____

ADDRESS: _____

DATE: _____

NAME OF PESTICIDE	LISTED CONTENTS (ACTIVE INGREDIENTS)	LISTED SAFETY PRECAUTIONS	TYPE OF PACKAGING	LOCATION IN THE HOME

Pesticide and Other Labels

Because many students come into contact with pesticides and will probably use them later in life, it is important that they know how to read completely the label on a pesticide container. To assure that students can read and understand such labels, the following activity is recommended.

Collect various containers for classroom use that are empty and clean. If students bring in empty containers be sure they are transported and handled safely. It is recommended that the teacher develop a set of slides or transparencies made from photocopies of these labels for a teaching aid. A variety of labels from drain openers to paint products may be used. Enclosed herein is a label (Figure 1) and questions from the Metro Toxicant Program as developed in Seattle. Use it as an example and then develop a similar worksheet using labels that are available to you.

Figure 1. Metro Toxicant Program Label for "Whiz Clean."

Figure 1. Metro Toxicant Program Label Written Details for "Whiz Clean."

USE WHIZ CLEAN ANYWHERE IN YOUR HOME

Bleaches Out Food Stains - Cleans and Disinfects

KITCHENS

Sinks: Whiz Clean cleans and whitens porcelain. Cleans stainless steel to a sparkle.

Countertops, Plastic Surfaces: Whiz Clean bleaches through food, beverage, ink stains. Wet sprinkle Whiz Clean, let soak for a while, then rub only as needed, rinse. Do not soak for prolonged periods.

Pots & Pans, Stoves, Ceramic Cookware: Whiz Clean cuts grease, scours off cooked-on food.

BATHROOMS

Sinks, Tubs, and Showers: Whiz Clean disinfects as it cleans.

Ceramic Tile, Fixtures: Whiz Clean cleans to a sparkle.

Toilet Bowls: Whiz Clean cleans and sanitizes. Sprinkle Whiz Clean liberally into bowl, scour and flush.

Vanity Tops, Plastic Fixtures: Special care should be taken in cleaning these surfaces. Let Whiz Clean work a minute or so with plenty of water. Rub gently if needed and rinse.

FOR TOUGH JOBS: For easiest results, let Whiz Clean work with water a minute or so, then rub as needed and rinse.

Other Uses: Whiz Clean cleans away soil and stains on cement floors, garbage cans, auto chrome, whitewall tires, out-door grills.

ACTIVE INGREDIENTS:	Trisodium Phosphate	13.50%
	Sodium Sesqul Carbonate	1.90%
	Potassium hypochlorite	0.45%
INERT INGREDIENTS:		85.15%

Includes Sodium tripolyphosphate, color, perfume, quality control agents. Whiz Clean averages 31% phosphorus in the form of phosphates.

QUESTIONS ABOUT THE "CLEAN WHIZ" LABEL

What is the brand name of the above product?

What is the product used for?

How does this product work?

List the ingredients and indicate which are the active ones.

How should this product be applied or used? (What are the directions?)

What precautions should be taken?

Add the % of each ingredient to the above list.

If you had 17 ounces of this product, how many ounces of active ingredients would you have?

How much actual product is used per each application?

If you use 3/4 ounce for each application, how long would it be until all of the container were used?

How much area would 3/4 ounce clean?

Are there any effects to human health or the environment which would result from use of this product?

What suggestions, if any, are given for disposal of the container?

Do you know of any alternatives to use instead of this product?

BEST COPY AVAILABLE

Using the following Figure 2 from the U.S. EPA which shows how to read a pesticide label, guide your students through several of the labels that you have on hand. Have various students in the class read one or more parts of labels. Be sure to point out to students the six main parts of the pesticide label. They are: EPA registration number; directions for use; precautions; first aid instructions; storage and disposal; and classification statement. These are explained in detail in Table 2 below. Discuss the importance and application of each part to the total pesticide poison prevention program, which such standardized labeling seeks to promote.

After all labels have been scrutinized and discussed, use the attached portion of a U.S. Government Printing Office publication, "Pesticides Are Poisons - Read The Label," to emphasize the ideas for protecting the user and the environment by reading, heeding and following all instructions for properly handling a pesticide or other chemical agent.

Figure 2. How to Read a Pesticide Label.

Table 2. Details Describing the Six Major Parts of a Pesticide Label as Written by the EPA.

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1. EPA Registration Number

   Look for this number on every product you buy. The number is your assurance that the product has been reviewed by the EPA and should be safe and effective when used as directed on the label. Older products may have a United States Department of Agriculture Registration Number.

2. Directions for Use

   Before you buy any pesticide, make sure the product is labeled for use against the pest(s) you are trying to control. Read all label directions thoroughly before you open the container. Use only the amounts recommended, at the time and under the conditions specified, and for the purpose listed. (Don't think that twice the dosage will do twice the job. It won't. You may harm yourself or whatever you are trying to protect. It is also a violation of Federal law.)

3. Precautions

   Read the precautions carefully. The most toxic products will be labeled "DANGER-POISON." The word "WARNING" on the label means the product is less toxic, but extreme care must be exercised in its use. The word "CAUTION" will appear on those products which are least harmful when used as directed. Pay particular attention to warnings about keeping children and pets out of treated areas and about special clothing that should be worn when using certain chemicals.

4. First Aid Instructions

   Know what to do if someone is accidentally poisoned by a pesticide. Check the label for "Statement of Practical Treatment." This information will give instructions for immediate action. Then, ALWAYS call or get to a doctor or hospital right away. Be sure to take the pesticide label with you. Write the name of your doctor or local poison control center here and keep it handy.

   _____ Number of Local Poison Control Center

5. Storage and Disposal

Read and follow all directions for storage and disposal of pesticide products carefully. Keep all pesticides out of the reach of children, preferably under lock and key.

6. Classification Statement

Since October 21, 1977, all pesticide products have been classified for either "general" or "restricted" use. Restricted use pesticides are highly toxic or require special knowledge or equipment for application and, therefore, will generally not be available for sale to the homeowner. Look for the statement "General Classification" on the label at the beginning of the directions for use to ensure that the pesticide is classified for use by the general public. Remember: By reading and following all label directions and warnings before you buy or use any pesticide, you protect yourself, your family and the environment from serious accidents.

ACTIVITY 2: Toxicity Testing

Pesticides are considered toxic or poisonous to their target species. What is a toxic effect? This activity will show the toxic effect of common table salt (NaCl) on plants such as beans.

Effect of table salt on seedlings

Have the class germinate and grow five lima bean plants to about 3-8 inches in height. Have various concentrations of salt in distilled (or tap) water prepared and labeled for daily application of 10 ml. Salt water by weight could be 0, 1, 3, 5, and 10%. Make sure that the 0% is understood as a control for comparisons. Combine the data from the study for the class as a whole. Have the students water these plants using the same solution daily. Have them record their plants' heights daily and note any leaf changes such as color and size. Ask them to comment on the toxic responses noted. Have them plot their data in graph form and also develop a set of average data for the whole class to plot.

Effect of table salt on germination

Some pesticides act on the seeds of a plant so that germination is altered and/or stopped. Have each student germinate five lima bean seeds in a covered Petri or other

dish. Use a clear dish with a paper towel so that the above salt solutions can be added to the paper towel. Have them note the number of days to germination, initiation and other observations relating to shoot growth, root growth and color change. Other smaller and more sensitive seeds may be substituted as available.

ACTIVITY 3: Survival of the Fittest

This class activity could be explained as a game of chance. When pesticides are used, some insects are able to survive by having genetic "immunity," which is then passed on to their offspring.

Have students stand at the front of a class as insects. Inform them that they will receive 10 mg of pesticide per kg of body weight. Let them draw cards out of a paper bag. All but five of the cards say, "You have been sprayed and are terminated. Please sit down." The other five cards can read, "Congratulations! You survived the spraying." Have students calculate the percent survival (those living divided by the total number in class, then multiply by 100%).

Have those students sitting down come forward again, and explain that five individuals reproduced, and they are the new colony. They are munching on the crops again, and they will be sprayed again with the same concentration. Have them draw from the bag again. This time place ten survival cards in the bag. Again have them calculate percent survival.

This activity can then be expanded by announcing that because of the increased survival, a larger concentration will be sprayed (20 mg/kg body weight). Repeat the above sets of five and again with 10 survivors. If any "student" survives all sprayings, see if the class can calculate the amount of pesticide he/she has received. This could be done for an average student weight of the entire class such as 70 kg.

Discuss the options of the farmer and ask how the students would handle this problem if they were a farmer. This could include leading questions about costs, risks, benefits, alternative means of control....

Bioconcentration

As pesticides are passed up the food chain, their concentration in the higher consumers tend to increase. This activity needs to be preceded by an explanation of the food chain or food web. A bulletin board may prove useful as a teaching aid or transparencies of various food chains/webs can be used.

Have the students withdraw labels on 3 x 5 cards out of a large grocery bag. The labels should be as follows: two cards, human; four cards, big fish; eight cards, fish and the remainder, insect. Extra insect cards may be required for meaningful amounts of pesticides to be passed up the food chain. Have the students hold up their animal label. Divide the classroom with an imaginary line, and explain that the fish are to stay in the "water." Tell the insects that they have been sprayed and hand them a card that reads "Pesticide." They are to "fly" to the "water," where they are "eaten" by the big fish. This is done by the insects giving the big fish their label/card. The big fish are then "caught" and "eaten" by the humans who collect all of the pesticide cards. Inform the "fish" and "humans" that if they receive more than 10 pesticide cards they are to "die," and withdraw from the chain. The number of pesticide cards received resulting in death may be varied depending on the number of students involved.

Ask them to develop an explanation of bioconcentration based on this activity.

ADDITIONAL ACTIVITIES:

A collection of news articles related to pesticides can be initiated. The articles should be properly annotated and grouped according to type of pesticide.

Select one of the pesticides found in the home survey and have one of the students research the specifics on it. This could include target pest, route of action, how it was produced, how it is applied, who are the major consumers, and how effective it is.

Have a speaker from the State University Extension Service discuss the pros and cons of pesticide use from a farmers point of view.

Read and report on a book such as Silent Spring.

Report on various natural pest control methods such as screw worm sterilization via radiation, natural predators, use of preying mantids and lady bug beetles.

UNSAFE DISPOSAL PRACTICES

PURPOSE: To recognize conflicting viewpoints on toxic waste management and disposal practices, and to identify safe and unsafe practices.

LEVEL: 7-9

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Social Studies
Environmental Science
Language Arts

CONCEPTS: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

Environmental management is the result of the rational application of scientific and technical knowledge to achieve particular objectives.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 9-12. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 48-64. ED 266 951.

ACTIVITY: Issues relating to toxic substances are generally controversial because there is no clear proof on how many of the substances will react once they are in the environment and how they will react when they are mixed with other substances. Some people argue that there is enough proof and the proof indicates that many substances should be taken off the marketplace or be better regulated. Others believe there is not enough proof and that chemicals should be considered innocent until proven guilty. What do you think? Allow time for discussion.

Pass out the worksheets on pages 159-160. Instruct the class to read the worksheets and choose five issue areas. Direct them to provide a written response to Side A or Side B of each issue area they choose. Have each student complete the assignment in class or at home. In either case, allow for open discussion of the issue areas in class. Students who chose to answer "Side A" can debate their responses with students who addressed the same issue area but chose to respond to "Side B." Students should also write why they chose "Side A" over "Side B" (or vice versa) and what additional information they would like to possess that might support their position.

Tell the students that disposal of hazardous waste is often costly but the price of cleaning up the environment from indiscriminate disposal practices is far greater. The cost to human health cannot be given a cost figure.

Ask "How can we safely dispose of hazardous waste?" (Allow students time to respond.) Accept all reasonable responses.

ISSUE AREAS

Choose five of the following issue areas. After choosing an issue area, pick Side A or Side B to discuss. On a separate sheet of paper, write why you chose that position and what additional information, if any, you would want that might support your position.

ISSUE AREA I

SIDE A — Health and safety data on any chemical should be available for any member of the public who cares to look at it.

SIDE B — Manufacturers should be allowed to keep health and safety data secret.

ISSUE AREA II

SIDE A — Chemical companies should pay for health and safety tests of their chemicals.

SIDE B — Health and safety tests should be financed by public funds.

ISSUE AREA III

SIDE A — States or communities should be able to set disposal standards that are stricter than those set by the federal government.

SIDE B — States or communities should not be able to set standards that are stricter than those set by the federal government.

ISSUE AREA IV

SIDE A — We should try to limit our consumption of synthetic products--for example, nylon and plastic--that tend to generate toxic or hazardous wastes during their manufacture.

SIDE B — We should take full advantage of the benefits of modern technology and enjoy all products, hoping that a safe means for disposal of all toxic wastes will be developed at some point.

ISSUE AREA V

SIDE A — We should ship our hazardous wastes to other countries if they are willing to receive them.

SIDE B — We should not ship our hazardous wastes to other countries in lieu of finding safe technology for their disposal.

ISSUE AREA VI

SIDE A — The ocean is large and resilient, an ideal place for diluting hazardous wastes, and should be used for dumping.

SIDE B — Ocean dumping of hazardous wastes should not be used.

ISSUE AREA VII

SIDE A — The federal government should be able to determine where hazardous waste dumps should be located.

SIDE B — Local communities should be able to determine whether or not they want a hazardous waste disposal facility in their community.

ISSUE AREA VIII

SIDE A — We should keep local people employed with jobs--such as cutting grass and weeds on roadsides, weeding and landscaping public gardens, etc.,--rather than using dangerous pesticides.

SIDE B — Pesticides are convenient and very effective and should be used instead of alternative pest control measures.

ISSUE AREA IX

SIDE A — Household quantities of wastes are small enough that they should not be regulated like industrial wastes.

SIDE B — Household quantities of toxic substances should be regulated the same as industrial quantities. The same chemicals used by households are used by industries who manufacture or use the product.

MUNICIPAL WASTE CONTAMINATION OF GROUNDWATER

PURPOSE: To identify and list sources of municipal waste contamination and determine the characteristics of safe and unsafe disposal sites.

LEVEL: 7-9

FOCUS: Disposal of Hazardous Materials

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Taylor, Carla, editor. Groundwater: A Vital Resource, Student Activities. Knoxville: Tennessee Valley Authority, September 1985, pp. 53-55. ED 262 970.

ACTIVITY: This activity demonstrates how precipitation on a landfill can leach chemicals into the groundwater, contaminating wells, ponds, and streams.

Cut away the front of a box, and place sand in the box (slanted, see diagram). Place a landfill higher than the water reservoir. Place aluminum foil under the sand, overlapping the bowl, so that the "contaminated" (red food colored) water "leached" from the landfill will flow into the clean water below. The aluminum foil will form a trough from the landfill to the reservoir below. Place the bits of paper in the landfill before pouring the water. Stress that the landfill material could be there for years before it actually contaminates the water below.

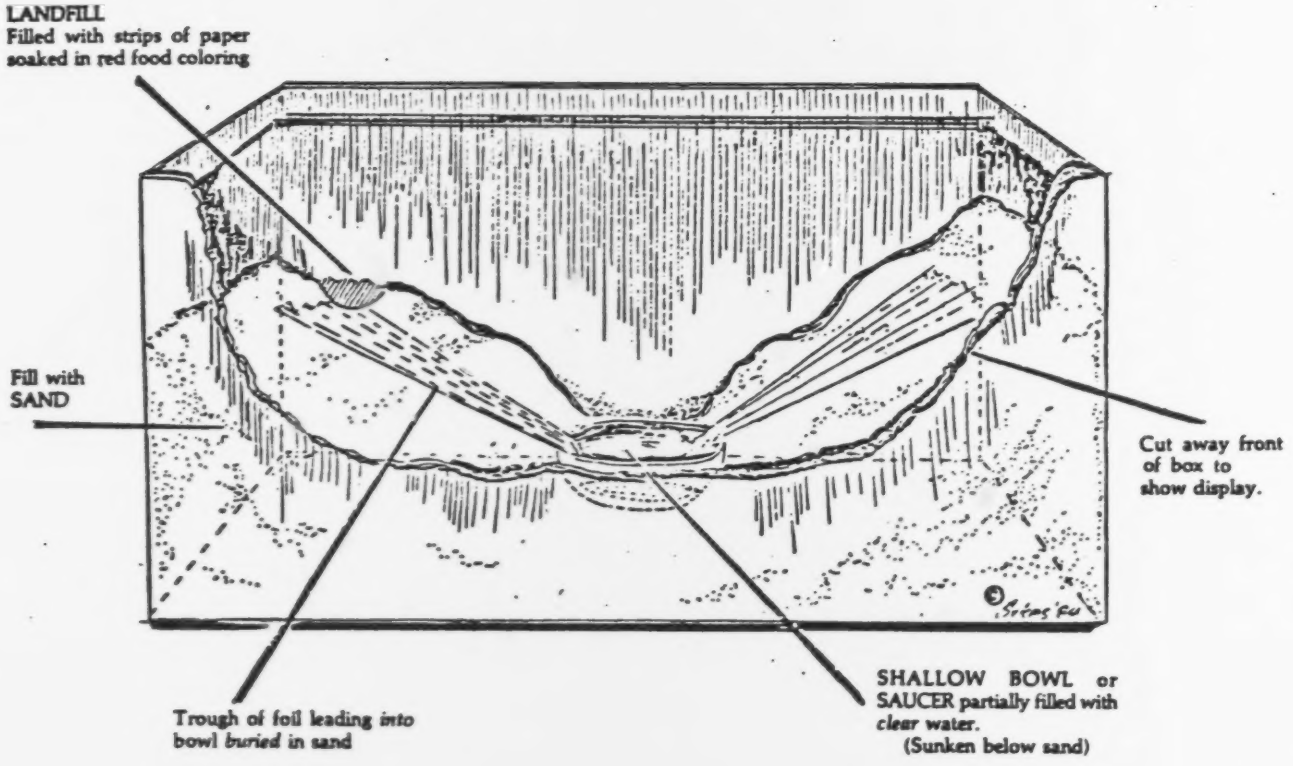
1. Hand out sheet (p. 163) on municipal contamination for participants to read.

2. Head an oral discussion on municipal contamination.

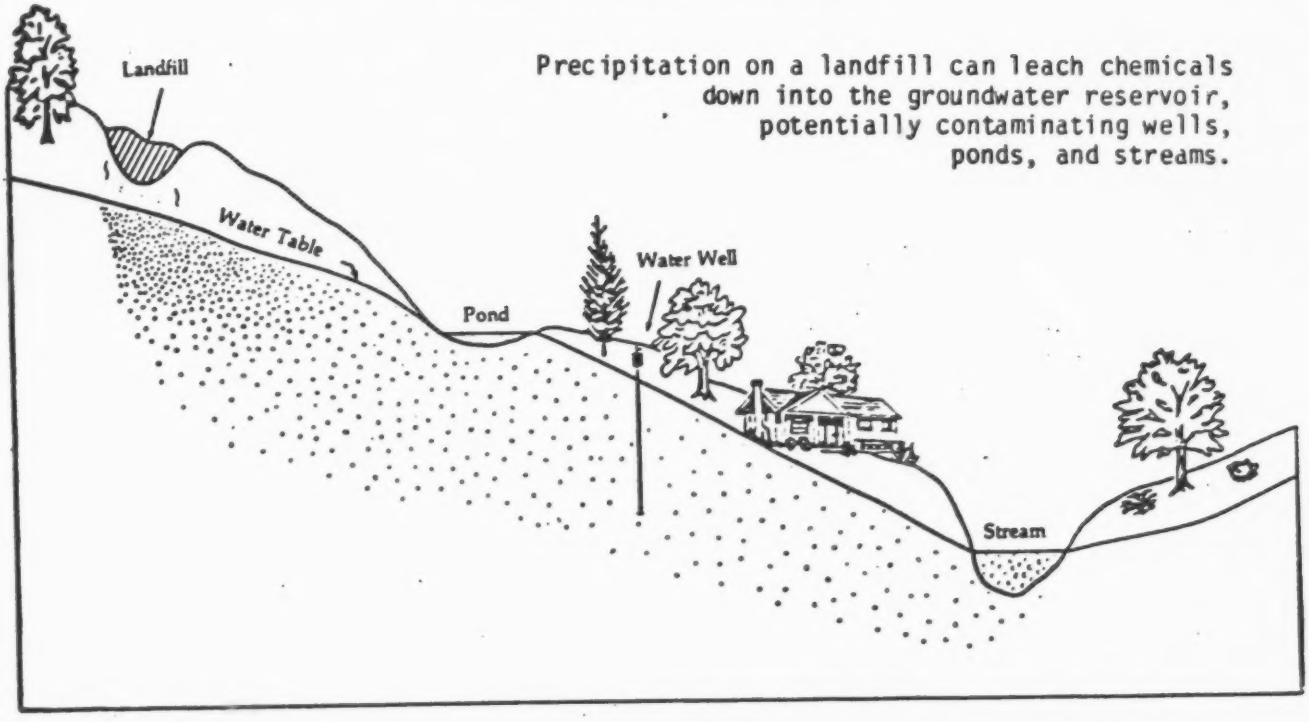
3. Demonstrate municipal waste contamination by pouring water on side without "landfill" FIRST and then on side with "landfill."

4. Discuss observations.

HOW PRECIPITATION OVER LANDFILL CAN CONTAMINATE GROUNDWATER


LANDFILL
Filled with strips of paper soaked in red food coloring
Fill with SAND
Cut away front of box to show display.
Trough of foil leading *into* bowl *buried* in sand
SHALLOW BOWL or SAUCER partially filled with *clear* water.
(Sunken below sand)

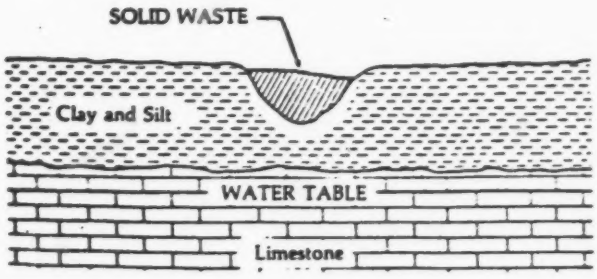
MUNICIPAL WASTE CONTAMINATION



Precipitation on a landfill can leach chemicals down into the groundwater reservoir, potentially contaminating wells, ponds, and streams.

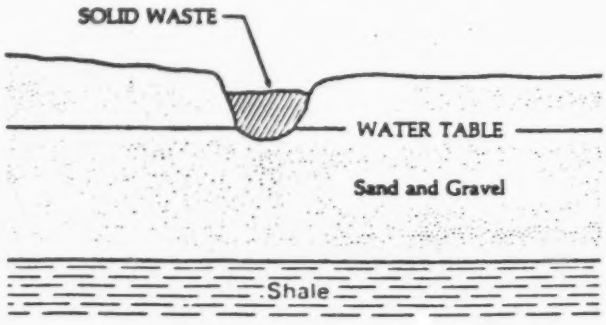
In the humid areas of the country, rain and snow on a landfill may carry dissolved substances downward, delivering biologic, organic, and inorganic pollutants to the groundwater. The degree of hazard depends on the geology of the site, design of the landfill, and character of the wastes.

Most municipal trash is disposed of in such landfills. Other important sources of municipal contamination include sewage effluent, sludge disposal, and leaky sewers.



Relatively Safe

Pollutants move slowly in clay and silt and many noxious compounds are absorbed on clay-mineral grains.



Unsafe

Pollutants entrained directly in groundwater.

(Illustrations from USGS Circular 601-F)

A DECISION-MAKING SIMULATION

PURPOSE: To analyze the processes involved in making decisions to resolve a hazardous waste landfill problem.

LEVEL: 7-9

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Environmental Science
Social Studies

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures and ecological principles.

REFERENCE: National Wildlife Federation. The Class Project, Conservation Learning Activities for Science and Social Studies. Washington, DC: NWF, 1982, pp. 65-69.

BACKGROUND: This simulation is designed to involve your students in a decision-making process concerning the placement of a hazardous waste landfill. It will help them recognize the complexity of our hazardous waste problem. Although the problem in Jackson Township is not being solved in precisely this manner, it is used as background for this simulation. Students might appreciate the opportunity to attend a local board or council meeting to get a feel for procedure, etiquette and atmosphere.

ACTIVITY: 1. Students may choose roles from the following list. The citizen groups can be as large or as small as you wish, to allow the entire class to be involved.

Brevard County Board of Supervisors (7 members)
President and Vice-President of the ECO-CHEM Control Corporation
President and Vice-President of the Anders Landfill and Dump Company
Citizens of the Brentwood neighborhood
Citizens of the Longworth neighborhood
Business people of the Millerton Shopping Mall
County Planner

2. Give each individual or group its role card, the problem sheet, and the newspaper clipping sheets. These sheets will give your students the background they need. The Board of Supervisors should be given all of the role cards.

3. Discuss the problem sheet with them. Before beginning, answer any questions they may have about their roles. It is also important to discuss the ways they perceive their roles. What are their responsibilities as citizens or board members?

4. Allow the students a day or two to prepare their statements and to conduct any research they feel necessary before presenting their statements.

5. Each group should choose a spokesperson to present its point of view to the board.

6. The Board chairman should start the meeting by explaining the issue and restating the alternatives listed on the problem sheet. Allow each group three minutes to present its statement to the Board. The Board can also decide to offer a different alternative not presented in the problem. If it does, its alternative should be heard first, then it should recess the meeting to allow the groups time to consider its proposal.

7. After each statement, the Board should be allowed to ask questions of the group. At this point, any group member can answer the Board's questions.

8. Allow about ten minutes for discussion and rebuttal after all statements have been heard.

9. Have the Board recess for five minutes to make its decision. They may choose not to use any of the sites, but they must choose an alternative if one of the three suggested sites is not chosen. When they announce their decision, they must give reasons for their choice and explain why they did not choose one of the other sites.

SUMMARY: These questions may be used to discuss the alternatives, issues and decision-making process used in this investigation:

1. What difficulties did the students encounter in preparing defenses for each of the positions?

2. What additional information would have been helpful in reaching a decision?

3. What part, if any, did the personal interests of the Board of Supervisors play in the Board's decision? Should the personal interests of the Board members play a part in the decision? Why or why not?

4. What factors did the Board of Supervisors consider when making its decision? What other factors do class members think the Board should have considered? What factors do students think should be considered in determining the welfare of the county as a whole?

5. Identify the people whose needs were considered by the Board as it formulated its plan.

   a. What effect did the special interest groups and their statements have on the Board? What part should special interests play in the Board's decision-making process?

   b. Are there county residents whose needs were not represented? Were their interests identified and considered in any way? How might they have been considered if they weren't?

   What makes a county resident important?

6. Was anyone looking beyond their own special interests and considering the welfare of the county as a whole? Did anyone's point of view change as a result of the hearing?

7. Were any compromises made to enable the Board to make its decision? If so, what compromises? Did the compromises deal directly with the landfill and its location? Did they provide for different kinds of compensations to those citizens near the landfill?

Finding locations for hazardous waste disposal is becoming a serious problem as local opposition to hazardous waste landfills increases. No one wants to live near a hazardous waste landfill. If we as an industrial nation are going to produce hazardous wastes, however, we must also dispose of them safely. Discuss this problem with your students.

When they presented their solution to the Brevard County problem, who did they make responsible for present safe disposal? Does the method they chose place responsibility with someone outside the county? Is it safe to place the responsibility elsewhere for monitoring or disposing of wastes generated in a community? What will happen when this landfill is full? Who will be responsible for future safe disposal? How could Brevard County plan for the future so that a similar problem doesn't occur?

PROBLEM SHEET

In Jackson Township, 165 families must get their water from a truck because their wells have been contaminated by toxic chemicals from a city-owned landfill. The township is solving the water problem by extending the muncipal water supply system through pipes to the neighborhood.

However, Jackson Township must still solve the hazardous waste problem by moving the chemicals to another area where they will not leach into the ground. If they are left in the present landfill, they will continue to leach into the groundwater supply and spread the contamination. Brevard County has a related problem. Chemicals from a leaking landfill must be moved to a secure one.

In Brevard County, the Board of Supervisors has decided to build a special clay-lined landfill for the chemicals that must be moved from the present disposal site. The clay lining keeps toxic chemicals from seeping down into the groundwater. Special wells, from which water is drawn and monitored for contamination, are built around the landfill. If chemicals are leaching from the landfill, they will show up in the water supply surrounding it. When the landfill is full, it will be capped with clay to seal it.

The money needed to build the landfill and operate it safely will come from county taxes. It will cost $2.3 million to build the landfill. Sending the drums to an operating EPA-approved site 800 miles (1287 kilometers) away would cost $1.4 million. The needed additional funds ($.9 million) for construction of the new landfill would be raised through a bond referendum. If this special landfill is built, Brevard County will be able to accept other chemicals for storage, giving the county an annual income of $100,000 to $200,000. Three possible sites in Brevard County have been proposed for the disposal:

30-acre (12.1 hectare) plot in the Brentwood neighborhood;
30-acre plot in the Longworth neighborhood;
30-acre plot in the Millerton Shopping Mall.

These sites have been specially selected because the nearest stream to all three sites is at least 500 feet (152.4 meters) away, and the water table is at least 50 feet (15.2 meters) below each proposed landfill site. Even though the county will follow EPA regulations in building and monitoring the landfill, the citizens in these areas do not want it near them.

The Board of Supervisors must decide how to solve the problem. Board members are elected, and three of them represent and live in the neighborhoods which are being considered as sites. A hearing, which promises to be lively, is being held to discuss the problem. The citizens of the three proposed landfill sites have asked for time at the hearing to state their objections.

Brevard County
Millerton
Shopping Mall
Longworth
City of Brevard
Stream
Brentwood
Eco-Chem
Landfill
800
miles
Legend
City
Neighborhoods
Landfill
Proposed
Landfill
Park
Commercial

ROLE: Board of Supervisors

The decision rests with you! Where should the chemical landfill be located? It is up to you to recognize your own special interests and the interests of each group making statements before the Board. The decision you make must go beyond the special interests of any one group and consider the best interests of the county as a whole.

Your first task is to select the three board members who live in and represent each of the three areas where the landfill could be located. Then you should consider these questions:

1. What are the advantages and disadvantages of each location for the landfill? What, if any, other options can you consider?

2. How do you take into consideration the feelings of the local citizens in making your decision?

3. What criteria are you going to use to analyze the statements made by the citizens? Make a list of them.

4. What factors besides the local citizen reaction will you be considering as you work toward a decision?

5. What parts will all of the factors play as you reach a decision?

6. Is there room for compromise in reaching a decision? If so, do you think citizens will be willing to make compromises? In what ways? What compromises can you offer them?

You can ask questions of each group after it has presented its point of view. As a group, consider all the alternatives open to you for disposal of the chemicals. If you like, you can consider other solutions as well, and present them to the citizens at the beginning of your board meeting. If you decide to do this, recess the Board and allow each group to consider your proposal and develop lists of questions and concerns to be answered before you make the final decision.

ROLE: The ECO-CHEM Control Corporation

You manage an EPA-licensed landfill corporation for toxic waste disposal. You have a licensed chemical landfill located 800 miles (1287 kilometers) from Brevard County. The clean-up would be very expensive-$1.4 million for the county to send the chemicals from their dump to your landfill, but they would not have to build their own.

You must convince the Board that it is better to send the chemicals to your landfill. In your statement, answer these questions:

1. Why is your landfill safe?

2. How do you manage your landfill?

3. What advantages would there be for the county if it sent its chemicals to you?

ROLE: The Anders Landfill and Dump Company

You will get the contract to develop the landfill if it is built in Brevard County. You need the $2.3 million contract. Your business has been in a slump lately.

You must convince the Board of Supervisors to build the landfill in Brevard County. How will you do it? Discuss your strategy and prepare a statement for the Board. As you write your statement, consider these questions:

1. Why is it safe to build this landfill?

2. What are the advantages of having the landfill located in the county?

3. Why should you be given the contract? (What will you do to make sure the landfill is safe, that no seepage occurs?)

ROLE: County Planner

You think the landfill should be located in the county because the county will receive between $100,000 and $200,000 annually from companies bringing their chemical wastes to the landfill. This money can be used to increase services to the county. Parks and a new swimming pool can be built, and county roads can be improved. You must prepare a statement for the Board of Supervisors which will persuade them to locate the landfill in the county. Your statement should point out the benefits the county will be able to finance with the profits from the landfill.

You do not know where within the county the landfill should be built. However, you do not want it built in the area where you live.

ROLE: The Citizens of the Brentwood Neighborhood

You do not want the landfill in your area! You are afraid the chemicals will evaporate into the air or seep into the groundwater aquifer. Your water supply comes from the wells which you are afraid will be contaminated. There are many young children in your neighborhood and they play only 100 yards (91.4 meters) from the potential site for the chemical landfill. Your neighborhood begins 300 yards (274.3 meters) from the site.

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill elsewhere. The attached news clippings about other situations may help you. Try to answer these questions in your statement:

1. What health hazards does the landfill pose to you and your families?

2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?

3. Where should the landfill be constructed?

4. Are there better disposal methods? What are they?

5. Is there something the county supervisors could do which would minimize your objections to having the landfill close to your area? If there is, propose it to the Board during the hearing, if you are willing to make compromises in your position.

ROLE: The Citizens of the Longworth Neighborhood

You do not want the landfill in your area! You are afraid the chemicals will get in to the air and water and cause health problems. Your neighborhood is only 300 yards (274.3 meters) from the proposed landfill site.

Your taxes are being used to build the landfill. As taxpayers, you think you should have the right to stop the landfill. You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill somewhere else. The attached articles about other situations may help you. Try to answer these questions in your statement:

1. What health hazards does the landfill pose to you and your families?

2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?

3. Where should the landfill be constructed?

4. Are there better disposal methods? What are they?

5. Is there something the county supervisors could do which would minimize your objections to having the landfill close to your area? If there is, propose it to the Board during the hearing, if you are willing to make compromises in your position.

ROLE: The Business People of the Millerton Mall

You do not want the landfill in your area! You are afraid it will contaminate the water supply for the mall and hurt your business. People might not shop at a mall near a chemical landfill, and you might have trouble keeping employees if they are afraid to work near a hazardous waste landfill. You are also afraid that the chemicals could cause health problems for you since you spend six days a week at the mall. The landfill would be located at a site 300 yards (274.3 meters) from the mall.

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill somewhere else. The news clippings about other situations may help you. Try to answer these questions in your statement:

1. What health hazards does the landfill pose to you and your customers?

2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?

3. Where should the landfill be constructed?

4. Are there better disposal methods? What are they?

5. Is there something the county supervisors could do which would minimize your objections to having the landfill close to your area? If there is, propose it to the Board during the hearing, if you are willing to make compromises in your position.

NASA STUDIES A-WASTE DISPOSAL IN OUTER SPACE (May, 1980)

NASA has awarded a $296,000 contract aimed at learning if potentially dangerous nuclear wastes can be fired into orbit around the sun, into another solar system, or elsewhere in the universe. The company receiving the contract is to evaluate how best to launch nuclear trash, where in space to put it, how to protect the payload during launch and in space, and how to bring the payload back if there is an aborted liftoff. The program is a joint effort by the National Aeronautics and Space Administration and the Department of Energy.

PROCESSED WASTE 'SAFE ENOUGH TO EAT' (June, 1980)

In Hooksett, New Hampshire, the proposed $10 million hazardous waste processing plant will convert acids, alkalis, and heavy metal sludge into a rock-like substance that can be used as a base for highway construction or as an erosion control material. "It will yield by-products safe enough to eat," says the president of the firm that wants to build the processing plant.

JUSTICE DEPARTMENT SUES WASTE PRODUCERS (July, 1980)

The Justice Department has asked the U.S. District Court in Baton Rouge, Louisiana to keep twelve oil and chemical companies from disposing any wastes, hazardous or otherwise, at two sites near Baton Rouge where carcinogens and poisons are leaking into the environment. One of the sites is a large vertical hole drilled into a bluff. It was closed several years ago after it had been filled with waste, and covered with plastic and a layer of earth. Since then the plastic has disintegrated and the earth has washed away. The Justice Department has asked the court to order the defendants to repair the plastic sheeting and install fences around the areas after doing tests and sampling.

COMPANIES DETOXIFY WASTES CHEMICALLY (September, 1980)

Companies worried about leaking chemical drums or landfills like the Love Canal are trying to remove poisons from their wastes by chemically converting compounds into their harmless components. A researcher working to develop detoxification methods says, "If you have to store toxic wastes, you're just postponing a solution." An officer in another research company says, "Almost total reliance has been placed on landfills. But burial is just long-term storage." While some wastes can't be completely detoxified, their hazardous wastes can be limited. These processes are expected to increase in popularity because trucking of chemicals to special dumps is becoming more and more expensive.

TITAN SILOS FOR SOLID WASTE? (July, 1980)

The southern Idaho desert is the final resting place for thousands of tons of toxic chemicals. The 80-acre facility, which formerly housed Titan 1 nuclear missiles, offers the extreme in safe disposal: "encapsulation" in underground silos designed to withstand forces as severe as earthquakes and bombing attacks. The Air Force abandoned the sites in 1965 when the Titan became obsolete, and a disposal company later bought it. The president of the company says, "We are 3,300 feet above the water table, and there is nothing but impermeable clay between the site and the water table. It is locked up forever and cannot get out." A senior specialist with the Idaho Department of Health and Welfare says that the company has a pretty clean operation that meets all state standards. The company expects to buy other similar sites for disposal of more waste materials.

EXPLORING HOW TOXIC WASTE IS TREATED IN THE COMMUNITY

PURPOSE: To explore how toxic waste is treated in the local community.

LEVEL: 7-9

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Science
Social Studies

CONCEPT: Environmental management is the result of the rational application of scientific and technical knowledge to achieve particular objectives.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, pp. 41-42. ED 254 443.

ACTIVITY: By phone calls and/or site visits, find out the following:

1. What are the numbers, locations, and types of disposal facilities in the surrounding area? Are there old facilities, such as landfills, that are now closed?
2. Are plans for the development of new sites now being made? What are the time lines? Why are they needed?
3. Who is responsible for overseeing old, present, and projected facilities?
4. What criteria were or are used to determine the placement of the facilities?
5. How many years does it usually take to fill up a landfill in this community?
6. What companies in the area produce hazardous and toxic wastes? Where and how do they dispose of these wastes?
7. How are harmful levels of pollutants determined?
8. What tests of local groundwater are made? By whom? How often? What tests are not done? Why?

Suggested contacts for the above include:

- local sanitation department
- local Board of Health
- the state waste management agency
- the state Environmental Protection Agency, or similar agency
- local chapter of the League of Women Voters
- local industries
- local consumer protection agency
- city or county officials, state representatives, local Congresspersons.

One or more of these contacts may lead to possibilities of field trips. At least one such trip may appropriately be conducted, as an adjunct to this activity.

HOSPITALS AND HAZARDOUS SUBSTANCES - A RESEARCH PROJECT

PURPOSE: To identify the types of hazardous substances used and generated by a local hospital, along with its handling procedures and methods of disposal.

LEVEL: 7-9

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Health
Environmental Science
Social Studies

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Environmental management is the result of the rational application of scientific and technical knowledge to achieve particular objectives.

Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: National Wildlife Federation. The Class Project, Conservation Learning Activities for Science and Social Studies. Washington, DC: NWF, 1982, p. 73.

ACTIVITY: Hospitals generate a variety of hazardous substances. What kinds of hazardous substances are generated at your local hospital, and how does the hospital dispose of these wastes? In hospitals which administer radiation treatment, what special procedures are followed in the handling and disposing of their radioactive waste? What agency or agencies make and enforce the hazardous waste regulations for your local hospital?

MIDNIGHT DUMPING - A RESEARCH PROJECT

PURPOSE: To find out what current legislation and regulations exist concerning the disposal of hazardous substances and to determine the extent of their effectiveness.

LEVEL: 7-9

FOCUS: Social/Political Aspects

SUBJECTS: Social Studies
Environmental Science

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: National Wildlife Federation. The Class Project, Conservation Learning Activities for Science and Social Studies. Washington, DC: NWF, 1982, p. 73.

ACTIVITY: The term "midnight dumping" refers to the illegal practice of disposing of hazardous substances by dumping them at night on roadsides or other areas not equipped to contain these wastes. What are the penalties in your state for "midnight dumping?" What agency in your area enforces the laws regarding the illegal disposal of hazardous substances? Why is "midnight dumping" a problem? What are some of the reasons "midnight dumping" is used to dispose of toxic wastes?

HAZARDOUS AND TOXIC MATERIALS

TEACHING ACTIVITIES

GRADES 10-12

LABELING PRACTICES

PURPOSE: To identify proper labeling practices concerning potentially harmful and potentially toxic household products.

LEVEL: 10-12

FOCUS: Health Aspects

SUBJECTS: Health
Home Economics
Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 9-12. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 19-21. ED 266 951.

ACTIVITY: Divide class into groups of approximately four to six students. Hand out two sample labels and a worksheet (page 182) to each group. Make certain that each group has a household product label. EXCLUDE PESTICIDES IN THIS EXERCISE.

After the worksheets have been completed, allow time for presentation of information and discussion of results. Do students think that the labels contain enough information to ensure or encourage safe use and disposal by consumers? Why? Why not? As a homework assignment, have the students examine how the worksheet labels compare with products of a similar nature found in their homes or in local stores.

WHAT'S IN THIS STUFF?

Worksheet

Read: Use the sample label provided to answer the following questions.

1. What is the product name? _____

2. What is the intended use for the product? _____

_____

Read the following information if your product is a household product other than a pesticide. Be aware that disinfectants are considered pesticides because they temporarily "kill germs."

HOUSEHOLD PRODUCTS (Excluding Pesticides)

NOTE: When manufacturers list ingredients, the information may be confusing. Many chemicals are known by several different names. For example, toluene and toluol; and, aromatic naphtha and naphthalene are different names for the same chemical. Ingredient listings may also be presented in vague or general terms. For example, ingredients may be listed as "grease cutter," "corrosion inhibitor," "polishing agent," "coloring agent," "petroleum distillate," "aromatic hydrocarbon," or other vague terms.

1. List any general or vague terms that appear on the product label.

_____

2. List any warnings or precautions given. _____

_____

_____

3. Are there any indications that this product is toxic or hazardous?

_____

_____

_____

NOTE: There is no federal law that requires manufacturers to test their products for safety before being placed in the marketplace. The hazards of some consumer products are revealed after complaints are received by the Consumer Product Safety Commission, the organization responsible for enforcing the Hazardous Substances Act (HSA). It could take years before enough injuries occur and complaints are received before government or the manufacturer removes the product

from the market. Even when a product is removed from the market, injuries still occur because of the public's failure to follow re-call instructions or because they may be unaware that a re-call exists. If you suspect a product is hazardous or would like to see it sold in safer containers, write to the government: Consumer Product Safety Commission, Washington, DC 20207, or call their toll free number, (800) 638-CPSC. Also write to the manufacturer. They can only correct faulty products if they are made aware of the problem. By law, manufacturers are required to keep records of all adverse health effects caused by a hazardous chemical they sell. Your letter to the manufacturer can help to build a case against the product.

The Hazardous Substances Act is the federal law that establishes labeling requirements for consumer products containing hazardous ingredients (except pesticides). The law, enforced by the Consumer Product Safety Commission, also grants the Commission the power to ban substances posing such an extreme hazard that adequate labeling cannot be written. Carbon tetrachloride, for instance, was banned in 1970 for use as a household chemical (such as drycleaning agent, solvent, or glue) when it was found to cause liver and other body damage. Not many substances have been banned. Usually, the label or package is required to be changed to reflect the hazard. For example, the product may need to be packaged in child resistant containers.

If a chemical is considered a hazardous substance, by definition of the law, the product is subject to labeling requirements.

By definition, a hazardous substance is any substance or mixture of substances which is toxic, corrosive, an irritant, flammable or combustible, a strong sensitizer, generates pressure, is radioactive, or can cause substantial injury or illness.

It is important to note that the Hazardous Substances Act is concerned only with acute or immediate effects and does not take into consideration the long term (chronic) effects of a product. For products demonstrating an acute effect due to the result of a hazardous ingredient, the following labeling requirements exist:

a. Signal words must be used such as "danger," "warning" or "caution" depending on the level of danger. (Must appear on front label.)

b. Description of the hazard must appear, such as "vapor harmful," "flammable," etc. (Must appear on front label.)

c. A statement warning users how to avoid the hazard must appear. Example: "Use in well ventilated room."

d. A common or chemical name for the hazardous substance must appear.

e. If necessary, instructions for safe use and handling must be given.

f. First aid instructions must be given.

g. Name and location of manufacturer, distributor or repacker must appear on the label.

h. Statement, "Keep Out of Reach of Children," or its equivalent, must be used.

4. List any of the above requirements that appear on the product label.

_____

_____

_____

NOTE: Some products are not required to list product ingredients. This does not mean that potentially toxic ingredients are absent from the product. Rather, it simply implies that substances in the product are not considered to cause an immediate (acute) adverse reaction. Toxic chemicals may be present in a consumer product (without conforming to labeling practices) if the chemical falls below reporting requirements. For example, methyl alcohol used in quantities of less than 4% does not require labeling. Used in quantities of 4% and above, labeling is required. Methyl alcohol can cause blindness if ingested.

5. Can you think of consumer products that have no (or very vague) ingredient listings? If not, check your home or grocery store shelves for such products. _____

_____

_____

PRODUCT SELECTION PATTERNS

PURPOSE: To identify factors that influence product selection patterns.

LEVEL: 10-12

FOCUS: Health Aspects
Social/Political Aspects

SUBJECTS: Social Studies
Consumer Education
Home Economics
Health

CONCEPT: In many cases, alternative procedures or substitute materials may be used to avoid problems inherent in the use and/or disposal of hazardous and toxic substances.

REFERENCE: Purin, Gina, editor. Toxics in My Home? You Bet! Curriculum on Household Toxics for Grades 9-12. Sacramento, CA: Golden Empire Health Planning Center, 1984, pp. 67-73. ED 266 951.

ACTIVITY:

1. Suggest to the students that much of our lifestyle in the 1980's has been built around the use of easy-to-use convenience products. Many of these products contain some potentially hazardous ingredients.

2. Ask, "What influences people to start using these products?" (Write the questions and answers on the board.)

   Possible Answers:

   Parents have used them; relatives and friends use and/or recommend them; see it in stores; use at work; exposed to advertisements in magazines, on radio, and/or television.

3. Ask, "What reasons do advertisers give for using some of these products?" (Write the question and answers on the board.)

   Possible Answers:

   Convenient; quick; "new and improved"; effective; easy; social acceptance (stops ring around the collar, stops itchy dandruff, smells good, etc.)

4. Say, "Let's look at some of these advertisements." (Activity to be performed alone or in groups.)

Hand out magazines, scissors, glue, and worksheet (page 188). Have the students complete the following activity. Allow 20 minutes.

a. Find one ad which has a potentially harmful effect.

b. Cut out the ad.

c. Paste it on the worksheet, page 188.

d. Write under the advertisement:

- the potential harm;
- reason the ad writer is giving for persuading you to buy the product;
- how you think one can avoid or reduce the potential hazards associated with this product (when you use it); and
- the name of a less toxic substitute, if possible.

5. When time is up, have each student (or group) pin their work on a bulletin board or place it somewhere around the classroom. Have the students discuss their posters by:

a. telling the potential hazards associated with the product;
b. identifying the advertising gimmick (i.e., why should you buy it, what will the product do, etc.);
c. stating how potential harm can be reduced when using the product; and
d. identifying a safer substitute, if possible.

Encourage participation from the rest of the class.

6. Ask students if they think consumers can influence what products are manufactured.

Ask students to give examples of how consumer "buying power" influenced the manufacture of products.

One of the most obvious examples involves the health food industry. Once a small time operation, their products are now in competition with large industries who are now profiting by marketing products they once refused to manufacture. Not too long ago, preservatives in bread was the norm, stone-ground whole wheat was virtually unheard of and herbal teas were self-made concoctions. Today, preservative free bread, wholewheat products and herbal teas are packaged and sold by leading food industries who recognized the growing demand for such foods.

If we want less toxic products placed on the market and if we want to know the potential acute and chronic health effects associated with the ingredients used in consumer products, we can:

a. notify the manufacturer and elected officials of our interest and encourage others to do the same; and

b. start buying less toxic products (if a market is created, manufacturers will respond).

If we want to continue using products containing toxic chemicals, we should use them with utmost care.

WORKSHEET FOR ANALYSIS OF ADVERTISEMENT

(Paste Advertisement Here)

Potential harm of product

Reason for persuading you to buy the product

How can one avoid or reduce the potential hazards associated with this product when it is used?

What is a less toxic substitute?

TRANSPORTATION OF HAZARDOUS MATERIALS

PURPOSE: To recognize some of the safety factors involved in the transportation of hazardous materials, and to describe groups of hazardous materials.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Science
Social Studies

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 205-213. ED 263 015.

INTRODUCTION: This lesson is suitable for life science, general science, physical science or earth science classes. It can also be used to supplement many other science or social science classes in the middle or high school. The teacher should provide booklets, articles and clippings of actual highway accidents involving transportation of hazardous materials.

Students will be asked to record on a chart any safety placards they observe on the vehicles transporting hazardous materials. A classroom bulletin board would be an effective way to motivate the class. The State Police, fire bureau, safety supply company or Office of Emergency Services could all contribute by providing visiting speakers and slides of accidents. A local television station may have file tapes of transportation accidents which it would lend or allow a copy to be used while you are teaching this topic.

The suggested activity, Searching and Recording Placards, will show students the many ways hazardous materials are transported. It should provide them a better understanding of the safety precautions involved in the transportation of hazardous materials by packers, handlers, loaders and motor carriers. A time limit of one week should provide an adequate sample for their survey of placards found on transporting vehicles. After the survey is completed, the class will tally the results. These results may be placed on a bulletin board or graph boards.

BACKGROUND: Hazardous wastes may be transported as solids, liquids or sludge. Routinely, trucks are transporting these materials over our roads, highways and interstate transportation system. For the most part, the safety signs or placards go unnoticed by the majority of citizens.

We need to become more aware of the dangers involved with the transportation of these materials. This transportation is regulated by the U.S. Department of Transportation (DOT). They have classified the hazardous materials as to their nature and the threat which they pose to the public.

Hazardous waste is normally a solid material that has one of the following characteristics: ignitability, corrosivity, reactivity, toxicity. As a waste it is normally of little economic value and cannot be readily recycled. Hazardous waste transport must be accomplished safely from one point to another. The sender, carrier and receiver of such material must also prepare, carry and receive the accompanying paper work describing the material being transported. This written information is called the manifest. It provides a historical record and details of the transportation and relocation of the material moved.

Safety placards (signs) are designed and required to appear on the outside of the vehicles used to alert the public of the cargo's contents. Labels must also be placed on all material in the shipment to alert handlers of the dangers involved.

The DOT has published a book, Emergency Response Guidebook-Hazardous Materials to provide safety regulations that individuals must use while handling the hazardous materials. The safety placards used by carriers are displayed in this book, along with the proper procedures to be taken should an accident occur during the transport of these materials. Copies of this book will be invaluable to the students in the course of their study of hazardous waste transportation. It is inexpensive and can be ordered from J. J. Keller & Associates, Inc., 145 W. Wisconsin Av., Neenah, WI 549056 (1-800-558-5011).

ACTIVITY: Searching and Recording Placards

The students should locate visually and document placards that indicate the transporting of hazardous or toxic materials using the sketched diagrams in Figure 1 and the DOT Emergency Response Guidebook. A survey may be made while traveling, from a safe observation point away from the traffic on a major highway or interstate road or by observing passing trains from a distance.

SAMPLE TABLE

PLACARD NAME	DOT #	COMMON NAME OF CHEMICAL	TYPE OF TRANSPORTER	OBSERVATION LOCATION

ADDITIONAL ACTIVITIES:

Students may make a collection of newspaper articles dealing with hazardous materials. This collection should deal with recent events and current information on the transportation of hazardous materials.

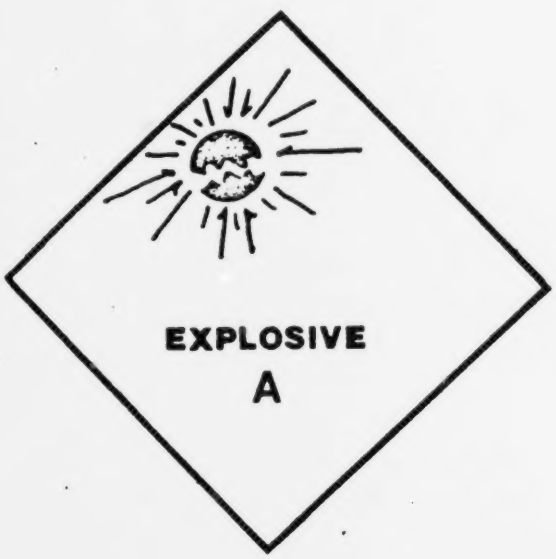
Classes may create placards to be used for the international transport of hazardous materials from one country to another.

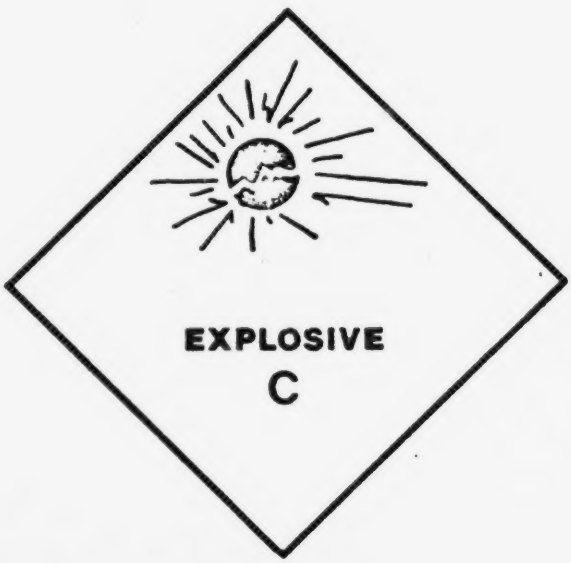
Guest speakers would further stimulate the interest in the careful use and handling of dangerous materials.

Students may play a safety placard game in the format of a spelling bee where they identify the placards.

Students may add the correct color, label and give chemical identification numbers to the placards sketched in Figure 1.

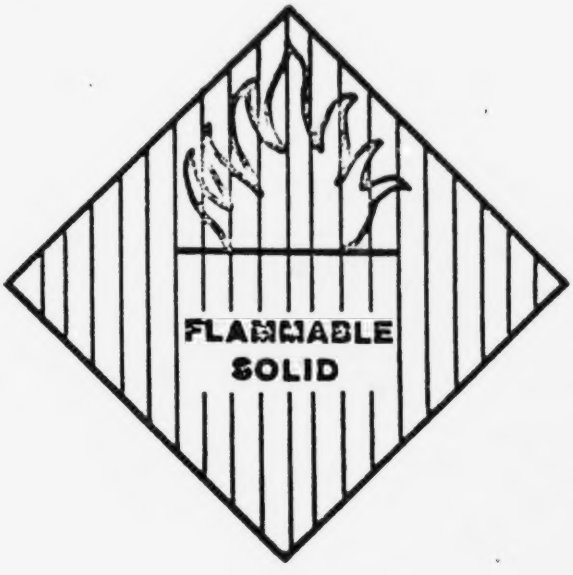
Figure 1. Placards for Use in the Searching or Other Activities.

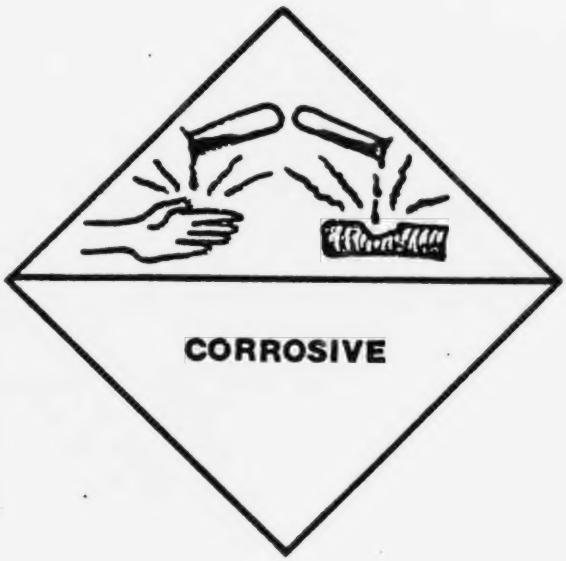




FLAMMABLE
LIQUID

FLAMMABLE
GAS


FLAMMABLE
SOLID


CORROSIVE

OXIDIZER

POISON

RADIOACTIVE

RADIOACTIVE

A TOXIC SUBSTANCE: LEAD

PURPOSE: To recognize the uses, major sources, and toxic aspects of lead.

LEVEL: 10-12

FOCUS: General Aspects

SUBJECTS: Physical Science
Chemistry
Health

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Llewellyn, Gerald C. et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 73-76. ED 263 015.

BACKGROUND: Lead is a heavy metal element; other than mercury, it is the heaviest of the common metals. It is pliable, easily bent, and easily scratched. Lead can also be extruded into various shapes but has a poor tensile strength and poor ductility. It is almost completely resistant to corrosion by salt water and hard water; however, distilled water containing dissolved oxygen will cause some corrosion. Lead water pipes were used centuries ago and occasionally we still read about a modern city uncovering an old lead pipe in its water system.

Lead and lead compounds are poisonous if ingested or inhaled. Some forms of lead may even enter the body through unbroken skin.

The United States is the world's largest producer of lead in its natural form, galena (a lead sulfide). Lead ore is subjected to a series of processes which removes specific impurities, and it is then sent to a variety of industries.

Lead monoxide (litharge) is the raw material for most other lead compounds. It is used to manufacture lead storage batteries, glass, ceramics and in the refining of oil. Red lead (minium) and white lead (lead carbonate) are both pigments. Organic compounds of lead are used as ingredients in paint driers, lubricating greases, and as oil additives. Tetraethyl lead is added to gasoline to prevent engine knock. Smaller quantities of lead have been used in plumbing, as cable covering, as a protective lining of storage vessels, in printing, and as a protective material in walls and clothing used in radiation work. Alloys of lead are used in a

corrosion-resistant coating for containers and as a roofing material. Due to the low melting point of lead, it is also used as an ingredient in solder and in some fire alarm systems.

A major use of refined lead is for storage batteries; this lead can be recovered and recycled. The second major industrial use of lead is as a gasoline additive; this form is not recovered. Tetraethyl lead can enter a human body through unbroken skin. It remains in body tissue as a soluble salt. Tetraethyl lead is also a major contributor to the lead particles in air pollution.

Lead is present in our food, our air, and our water. A contemporary American cannot avoid some level of contamination. Lead solder is used to seal some of our canned foods. In America the Poisoned (1982), Regenstein writes that an uncontaminated control group would be impossible to locate. Over-exposure to lead surely affected the progress of the Greek, as well as the Roman, civilizations. We know that the Romans used lead water pipes, and that they lined their cooking, eating, and wine-storage vessels with lead.

Our civilization is exposed to lead in the form of air pollution from lead smelting and from the combustion of leaded gasoline; however, exposure through food and beverages is still higher (except in Los Angeles and a few other highly congested areas). We accidently ingest lead in the form of pesticides remaining on unwashed vegetables, paints, solder used to seal food containers, lead pipes, and lead particles chipping off from certain ceramics, glassware, and cookware.

The average American in 1965 ingested 400 millionths of a gram per day. The average American in 1968 had 0.25 ppm in his blood. Garage mechanics and parking lot attendants had 0.34 ppm. According to the 1983 EPA report on lead, Americans ingested 100 mg of lead per day, giving about 1.25 ounces annually.

Research completed on the Greenland ice cap indicates that from 1750 to 1940 lead in the ice increased five fold and from 1750 to 1967 lead in the ice increased twenty fold. This research used the amount of sea salt in the ice as a control. The sea salts did not increase. Throughout the northern hemisphere of the earth, this exponential increase of lead contaminations exists. The same is not true in the southern hemisphere, where fewer gasoline engines are found. Air movement patterns probably prevent transfer of lead particles from north to south also. An estimated 430,000 tons of industrial lead finds its way to the oceans yearly. This was estimated in 1972. We know that lead accumulates in the livers of most fish.

Lead is a cumulative cellular poison. Less is known about the chronic effects than is known of the acute symptoms. In addition, there is a strong possibility of synergistic interaction with other environmental pollutants.

Lead poisoning is a chronic disease caused by the assimilation of large amounts of lead or lead compounds by the body. Lead may enter the body by inhalation, by swallowing, or by absorption through the skin. Lead enters the bloodstream and circulates as a soluble salt. Some of this material is absorbed by the kidneys and the liver, but most of the lead is eventually stored in bones. This has effects on calcium metabolism and on the formation of blood cells. The first noticeable changes in calcium metabolism cause diseased teeth, and a blue line (lead sulfide) on the gums.

Other symptoms include: severe anemia, pallor, weakness, loss of appetite, apathy, insomnia, constipation, premature aging, nervous irritability, erratic behavior, reduced learning ability, awkwardness, insanity, decrease in sperm production, malformations in sperm, sterility, miscarriage, stillbirths, premature labor followed by the death of the child, blindness, and lesions of the neuromuscular system, circulatory system, brain, and gastrointestinal tract. Lead is an enzyme inhibitor, inhibiting cell metabolism in specific organs. In adults, it is stored in bones; in children, it distributes all over the body leading to mental afflictions, brain damage, or death. The effects on the brain have been observed in cases of very low levels of lead. Babies and children have gotten lead poisoning from chewing the paint on their cribs, eating paint off window sills, or eating peeled paint from the walls of old homes. Since much of the housing stock of America's inner cities was built in late Victorian times, when the use of lead in paint and piping was at its height, almost any renovation will release huge amounts of gray lead dust into the air.

Even though lead is one of the most widely recognized environmental poisons, removing it from the environment is a highly complex and expensive task. We have come to rely on this metal for its many positive qualities. Also, it is already spread far and wide. In Human Ecology, the Ehrlichs state, "As we strive to reduce the percentage of contaminants per unit volume of effluent (air or water) to very low levels, the cost of the control measures in money and energy become very large. In fact, reducing the contaminant concentration to zero would require an infinite amount of energy. Long before we got there, of course, the environmental impact associated with supplying the energy for pollution control would exceed the impact of the pollution we were trying to clean up." Certainly levels should be reduced to a safe concentration even if the clean up is expensive.

ACTIVITY: Newspaper and magazine articles which are representative of incidents dealing with lead problems frequently appear. Such articles often provide examples of specific cases and/or additional information. Bring several such articles into the classroom; discuss them.

EFFECTS OF ACID RAIN

PURPOSE: To identify the possible effects of acid rain on living organisms and reactive effects on non-living materials.

LEVEL: 10-12

FOCUS: Biological Aspects

SUBJECTS: Life Science
Physical Science
Chemistry

CONCEPTS: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

Pollutants and contaminants are produced by natural and man-made processes.

Certain risks are taken and limitations experienced when manipulating the natural environment.

REFERENCE: Llewellyn, Gerald C. et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 235-241. ED 263 015.

BACKGROUND: Acid rain represents a relatively new environmental concern, and students should recognize that there is much controversy surrounding it. There are those who propose prompt action in further limiting sulfur dioxide emissions while conceding more research is needed to clarify the scientific uncertainties surrounding the topic. They contend that much is known and what is not known should not be used as an excuse not to act. Major insights into the workings of complex natural systems come slowly, they acknowledge, but stress that we cannot wait to make difficult political decisions.

Others say that such action would be extremely costly in terms of taxes and electrical rates with little or no possibility that the problem would be addressed successfully. They cite what they consider as hard evidence in scientific literature that reducing sulfur dioxide emissions has not reduced the acidity of rain so far. They point to alternative explanations of "dying" lakes and forests and alternative ways of dealing with the problem that they consider more consistent with scientific data and less costly by possibly billions of dollars.

As students engage in the following activities, they should be aware that they are working on specific aspects of a much larger and more complex issue. A good presentation of the positions summarized above can be found in pieces on the editorial page of the Wall Street Journal, June 28, 1984.

Acid rain is probably caused by emissions of sulphur dioxide and nitrogen oxides which combine with moisture in the air to produce sulphuric and nitric acids. Sandstone sculptures produced in the 1700's in Germany remained virtually undisturbed for 200 years until the early 1900's. By 1969 they had become severely eroded because of the action of acid rain. There is a debate over the extent to which electric power plants which burn fossil fuels contribute to the problem. A secondary source of pollution seems to be automobile exhausts. The Clean Air Act of 1970, and subsequent amendments in 1977, were enacted to address the problem of acid rain. In an effort to improve air quality around the plants, many utilities raised their smoke stacks, some as high as 2000 feet. This may have served to spread the pollution further.

The U.S. releases about 50 million metric tons of sulfur and nitrogen oxides into the atmosphere yearly. Substantial amounts of these chemicals are converted into acid rain. Actually acid rain is a misnomer. It can be acid snow, sleet, gas, aerosol, solid particles.... "Acid deposition" would be the more correct term to use.

ACTIVITY 1: Learning About pH:

The pH scale is a number scale ranging from 0-14 which is used to determine the acidity of a solution. A strong acid is indicated by a 0 reading; 14 means a strong base (alkaline), and 7 represents a neutral reading. The acidity of a substance is determined by the percentage of Hydrogen ions present, hence the abbreviation, pH. The pH values increase logarithmically, not arithmetically. Therefore, a pH value of 4 is 10 times more acid than a pH of 5 and 100 times stronger than a pH of 6.

In separate containers, pour small amounts of the following liquids; rain water, tap water, vinegar, dissolved baking soda, ammonia, lemon juice and cola soft drink. Use pH paper to determine the pH of each liquid. Have students rank these substances on the pH scale. Add a marble chip (the kind used in landscaping will do) and a tarnished penny to each of the solutions. If balances are available, have students weigh the marble pieces before and after the experiment. Observe after 48 hours and record the visual change of each liquid on the marble and the penny.

Have students explain why the Statue of Liberty, marble statuary, and grave headstones have undergone extensive deterioration in recent years.

To economize on the use of pH paper, a drop or even less of the solution to be tested can be spotted on a piece of test paper that is less than 5 mm square.

To illustrate the effect of the buffering action that occurs naturally in some lakes, have students drop pinches of agricultural lime into a vinegar solution until a pH range between 5-6, that of normal rain water, is achieved. If brought to a pH of 7, this process is known as neutralization. Students should test the beakers or cups of liquids from the preceding experiment to determine if the pH changed in 48 hours. Both students and teachers are warned to take care and make every effort to respect these common agents as potentially dangerous chemicals. They can be flushed individually down the drain as a disposal procedure or completely neutralized prior to disposal.

A True or False Practice Quiz

1. The lower the numerical value on the pH scale, the more basic (alkaline) the solution will be. (F)

2. A pH of 3 is 10 times more acid than a pH of 4, and a pH of 4 is 10 times more acid than a pH of 5. (T)

3. Granite and other igneous rocks resist weathering by acid rain. (T)

4. Granite and other igneous rocks are good for buffering the effects of acid rain on lakes. (F)

5. Acid rain mainly affects areas close to its source. (F)

ACTIVITY 2: How Acid is the Rain? An Experimental Survey:

You may wish to have the students bring in samples of rain (or snow) a few days prior to this activity. It is also possible to have them collect it and freeze the precipitation for a month or so ahead of class use. Instruct them to use a glass jar or cup lined with a new plastic bag (zip lock type is nice) with the top edge turned back over the rim. This collection device should be placed in the open, because run-off from tree leaves or gutters will include other pollutants. Samples should be clearly identified by date, name of collector, and location of collection.

Have students measure the pH of their samples. Record this on a class chart. If possible, put a street or county map of your geographic area on a bulletin board and have students locate their collection sites using tacks. If tacks are close together, compare the pH of these samples. Additional samples could be collected and recorded over an extended period of time, and the factors that might cause different readings could be discussed.

Suggested Topics for Class Discussion

Why are the samples collected so similar or different in pH?

What natural conditions might affect the pH of the samples? (Wind direction, type of soil involved, collection at the beginning or end of the rain.)

What man-made features affect samples? (Nearness to major highways, proximity to industry, open pit mining areas, recently plowed fields.)

How could you use this information?

What is your personal reaction to this activity?

ACTIVITY 3: The Effect of an Acid Environment on Aquatic Life:

Using vinegar, agricultural lime and tap water, set up a series of containers having pH values of 3, 4, 5, 6, 7 and 8. After measuring the pH of tap water, vinegar can be added to lower the pH and the lime is added to produce higher pH values. Add several hydra or daphnia (available from a biological supply company) or a single species of small aquatic invertebrate collected from local ponds. Using a hand lens or stero-microscope, observe the organisms for 30 minutes, recording any apparent changes. The teacher may choose to allow the solutions to stand for 48 hours and record any "long-term" effects.

What pH range appears to be the most favorable?

What effects occur as the pH was lowered?

What effects could this have on fish, birds and humans?

ACTIVITY 4: The Effect of an Acid Environment on Plants:

Mix large quantities of water having pH values of 3, 4, 5 and 6 using vinegar and lime as described in the previous activity. Fill four paper cups with potting soil, poking holes in the bottom for drainage, and plant 10 seeds of one type in each cup. Radish, pea, rye grass or any kind of bean

will do. Water one cup of plants with water having a pH value of 3, the other cup with pH 4 water and so on. Try to keep the pots uniformly moist. Permit growth for at least three weeks and preferably longer, observing and recording the growth rates and other pertinent data such as leaf size and color, general health conditions, germination time and percent germination. As a class, discuss what effect low pH values have on the developing plants.

To ensure reliability in drawing conclusions, the class should be divided into several groups with each group conducting identical tests.

Extensions and Applications as Applied to Acid Rain

Students could write to classes or relatives in different localities asking for pH readings of rain samples taken in that area, along with a description of the area (rural, urban). Students may want to design a questionnaire to be sent with each request, asking about the process they used in collecting the data. Then they could collect and analyze the returned data.

Scientists have found that the more acidic the water, the greater the amount of metals, such as aluminum, zinc, copper and mercury that can be dissolved in the water from surrounding polluted soils. These metals may be highly toxic to fish and serve to compound the problem. Drinking water having low pH levels can dissolve lead solder in pipes which can result in lead poisoning. The pH of the water also influences the amount of dissolved copper in drinking water. A student may search current periodicals to find articles related to this aspect of the problem and report them to the class.

Acid rain also affects mature leaves by stripping away the waxy coating that protects the leaves from infestation by insects and water loss. Pitting of leaves, shortened needles and bleached chlorophyll also result in a slowdown in photosynthesis. This apparently has been the case in Canada, Germany and Scandinavia where forests have been severely damaged. In the U.S., similar damage is suspected in California, Tennessee, North Carolina and Virginia.

As a class, students may design an experiment to test this effect. They would search the current literature for ideas. Class discussion may center on plant selection such as why some species are more tolerant and how long would it take to observe a response. Other parameters to be considered would include the method of application, experimental design, and pH of the control group.

For a class project, students may design a bulletin board or free standing acid rain display to explain the topic or their experimental findings.

Students may search current periodicals to determine the status of provisions of the Clean Air Act and what industries have done or not done to comply with this legislation.

THE ACID RAIN CONTROVERSY

PURPOSE: To evaluate statements on the bases of their objectivity and substantive content.

LEVEL: 10-12

FOCUS: Hazardous Materials in the Air

SUBJECT: Language Arts
Science
Social Studies

CONCEPT: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Factor, Lance. Acid Rain Materials for Classroom Use. Washington, DC: National Endowment for the Humanities and National Science Foundation, June 1983, pp. 1-4. ED 247 133.

ACTIVITY: "Our knowledge of acid rain resembles swiss cheese - there are a lot of holes, but some substance." (anonymous)

Here are some examples of what experts have said about acid rain.

A. ---48,000 lakes in North America are doomed to destructon.
---$8 billion estimated lost from the American economy.
---thousands of individuals are physically affected - some fatally.
---all because of ACID RAIN.[1] (Atlantic Salmon Foundation)

B. "...there is "overwhelming" circumstantial evidence supporting claims that power plant emissions are a major factor in forming acid rain. ---There is little probability that some factor other than emissions of sulfur and nitrogen oxides is responsible for acid rain."[2]

C. Some of the impressions of increasing acid rain may well have arisen from comparisons of data obtained by different methods, with the tendencies to detect differences due to the method of analysis rather than the rain itself.

It is premature to state that rainfall is not increasing in acidity anywhere. But not one of the reports of increasing acidity has stood up under scientific challenge.[3]

D. "Without question, acid rain is the most serious and deadly environment problem that man has ever faced. Acid rain knows no boundaries and its effects are catastrophic."[4]

E. "There is no evidence that acid precipitation is either a major problem or a threat to public health nor is there any scientific consensus pointing to a broad crisis associated with precipitation acidity.[5]"

F. Acid precipitation is a non-issue that has been blown out of proper proportion by antigrowth environmental extremists.[6]

The tones of these statements are quite different. Suppose we had a scale from 1-10 with 10 representing the most extreme view (offering the least evidence) and 1 representing something approaching rational criticism. Where would you place each of the quotes? Put letters over numbers.

Exercise 1:

1----------/
1 2 3 4 5 6 7 8 9 10

In making your evaluations you relied on your background knowledge and your innate sense of reasonableness. In a sense, you tried to look for reasoned criticism which stands behind those overt disagreements.

There is a world of difference between disagreement and reasoned criticism. When one person asserts an opinion and another denies it, he or she states an opposing position. This is disagreement. Such conflicts are common, and they do occur in science as well as everywhere else. Reasoned criticism, however, is a process of evaluating the evidence which supports a position. Science has developed many procedures for producing evidence, and, of course this is helpful. Unfortunately, the evidence may be inconclusive and require interpretation. Reasoned criticism and rational deliberation, therefore, frequently require experts and educated laymen to discuss the strengths and weaknesses of various kinds of evidence.

Here we encounter a very important feature of policy debate which occurs in virtually every environmental issue but is seldom publicly stated or openly admitted. One cannot evaluate the scientific information, the evidence, or the facts without introducing or presupposing some preferences or values. For example, the Atlantic Salmon Foundation directly

represents the fisherman of Canada's coastal provinces. They will naturally look for evidence which supports their beliefs that acid rain is caused by power plants in the United States and that acid rain is destroying the salmon spawning grounds. By contrast, the Edison Electric Institute represents utility companies in the United States, and it will try to interpret the evidence to support the belief that "there is no evidence pointing to a broad crisis" (quote F above). Both sides can agree on certain facts, others are in dispute, and they disagree over the inferences or interpretations placed upon those facts. If one wants to understand a complicated issue, like the acid rain debate, one must identify the interpretations which are interwined with the facts. Sometimes there is a clear distinction between facts and values (or interpretations) but many times there is no sharp distinction. This exercise asks you to use your knowledge of basic chemistry to identify where and how facts are interpreted or evaluated. A person does not have to be an expert in facts in order to become aware of the ways in which those facts are used or twisted.

One way to evaluate evidence is to begin with facts about which both sides agree. Some of this agreement can be explicit, but it can also be shown tacitly, by silence or by partial acknowledgement that an allegation appears credible.

These are some uncontroverted facts:

1. Some coal-burning power plants emit large amounts of sulfur dioxide and nitrogen oxides.

2. Sulfur dioxide and nitrogen oxides react with oxygen and moisture to form sulfuric and nitric acids.

3. Rain is sometimes more acidic than generally expected or accounted for. Available data show that precipitation measured in certain parts of the United States, particularly the eastern part of the country, has a pH below 5.6.

4. Available data show that 264 Adirondack lakes are no longer able to support fish because of high acidity. 256 more lakes are approaching the same fate. In sum, in certain lakes the acidification process has begun and appears to be increasing.

These facts say nothing about causes. Did you notice that (1) and (2) talk about power plant emissions while (3) and (4) talk about the condition of rain and lakes? Sometimes the way facts are arranged or organized can make you think there is causal connection between them. Did reading (1) and (2) first make you think they were the causes of acid rain? Scientists

working for the utilities maintain that there is merely a correlation or coincidence between emissions and increased acid precipitation. They believe no one has established a direct causal connection; consequently, there may be contributing causes other than emissions which produce acid rain. The fundamental scientific question is, do we know enough to say that increased emissions cause acid rain, or must we restrain our judgments to merely indicating a correlation between emissions and pollution?

Environmentalists build their case for acid precipitation on three broad assertions:

---That it results in large part from man-made emissions of oxides of sulfur and nitrogen;

---That these emissions are transformed in the atmosphere to sulfuric and nitric acids, and can be transported great distances; and

---That these acids are then deposited where they harm vegetation, soils, surface water, and materials.

---

1. Comptroller General of the United States. "Debate over Acid Rain." Gaithersburg, MD: U. S. General Accounting Office, GAO/EMD-81-131, 1981.

2. Committee on Atmosphere and the Biosphere. "Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequence of Fossil Fuel Combustion," 1981.

3. Katzenstein, A. W. An Updated Perspective on Acid Rain. Washington, DC: Edison Electric Institute, 1981.

4. Comptroller General of the United States, op. cit.

5. Before the Rainbow--What We Know about Acid Rain. Washington, DC: Edison Electric Institute, 1981.

6. Ibid.

POLLUTION OF SOIL AND WATER

PURPOSE: To be able to identify potential toxic sites through a study of indicators such as abnormal pH and chloride contents.

LEVEL: 10-12

FOCUS: Hazardous Materials in the Water

SUBJECTS: Physical Science
Chemistry

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, pp. 50-51. ED 254 443.

BACKGROUND: One of the many indicators of hazardous waste are abnormal pH and chloride content. The purpose of this experiment is to see if you can identify any local areas that are potential toxic waste sites. Because of car emissions and winter salting, roadside areas are particularly susceptible to pollution.

Materials:

7 clean test tubes	pH paper
labels	silver nitrate solution
test tube rack	medicine dropper
distilled water	7 bottles with covers or caps

ACTIVITY:

1. Obtain 6 clean stoppered bottles.
2. Locate 3 different sources of water (ponds, marshes, streams, etc.), and put a sample of each in your first three bottles.
3. Carefully label each bottle with the location of your sample.
4. Locate 3 different locations from which to take soil samples (roadside, meadow, near a stream, forest, etc.). Fill the remaining bottles about 1/4 full and label each carefully.
5. Bring all 6 bottles back to the lab.

6. Add distilled water to your soil samples and shake. Allow the contents to settle.

7. Obtain a bottle of distilled water.

8. Test the liquid in each of the 7 bottles with pH paper, and record your results in the chart below.

9. Take 7 clean test tubes. Label them according to your original set of bottles. Add a dropperful of each sample liquid to the corresponding test tube. Make sure you rinse the dropper in distilled water between samples.

10. Add 5 drops of silver nitrate to these test tubes and look for any clouding of your solution (clouding or a white precipitate indicates the presence of chloride). Be careful in using silver nitrate, it is poisonous and stains skin and clothing. Record your results.

Results:

Location of Sample	pH	Chloride (+ or -)
Distilled Water		

Discussion:

1. Why was the test tube of distilled water included in this experiment?

2. Why was it necessary to rinse your dropper with distilled water?

3. Compare your results with those of your classmates. Do you see any patterns showing how pH and salt content differ in different areas? Explain.

4. Do any of your results determine conclusively that an area is a potential hazard? Explain.

5. If any of your results were negative, could you conclude that the area was uncontaminated? Why?

6. What other factors besides toxic substances could alter pH and salt content in these areas?

7. If you and your classmates did discover a potential toxic waste site, whom should you contact?

EFFECTS OF pH AND SALT ON LIVING ORGANISMS

PURPOSE: To study the effect of pH and salt on living organisms, to determine the toxic thresholds of a typical organism.

LEVEL: 10-12

FOCUS: Biological Aspects

SUBJECTS: Biology
Chemistry

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, pp. 60-61. ED 254 443.

ACTIVITY: Abnormal pH and salt concentrations can suggest the presence of hazardous waste. The intention of this experiment is to study the effects of these factors on organisms, and determine what concentrations of acid, base, and salt are actually toxic to the organisms being studied.

Materials:

Microscope	Stock solutions with various pH and salt concentrations
Depression slide	
Cover slip	Euglena

Procedure:

1. Obtain a microscope and a clean depression slide.
2. With a medicine dropper, take a sample from one of the growth solutions provided by your teacher, place it on the slide, and cover it with a cover slip.
3. Place the slide on the stage of your microscope, and focus using low power.
4. In order to determine the RELATIVE number of living organisms in each solution, you will count the number of organisms seen in the field of the microscope in one minute. When you are ready to start counting, have your lab partner say go and then time you for half a minute (if there are a lot of organisms, you may have to estimate).

5. Record the number in the appropriate place in the chart below.

6. Rinse your slide with distilled water.

7. Repeat this procedure for each solution.

SALT CONCENTRATIONS

	0%	.2%	.5%	.7%	1%	3%
# of organisms observed						

pH

	1	3	5	7	9	11
# of organisms observed						

Graph the number of observed organisms vs. pH and the number of observed organisms vs. salt concentration.

Compare your results with those of your classmates.

Discussion:

1. Why is it important to look at class data?

2. What ranges of pH and salt concentration seem to affect these organisms adversely?

3. Can you conclude that your results would have been similar no matter what organisms were used? Explain.

4. How would you modify this experiment to give you more information on the effects of acids, bases, and salts on other living organisms?

5. How would you determine acceptable limits for toxic substances in water?

6. Find out how the EPA sets its standards.

NITRATES IN GROUNDWATER

PURPOSE: To identify the sources and harmful effects of increased amounts of nitrates in groundwater.

LEVEL: 10-12

FOCUS: Hazardous Materials in the Water

SUBJECTS: Chemistry
Biology
Earth Science

CONCEPT: Increasing human population, higher standards of living, and resultant demands for greater industrial production promote increasing environmental contamination.

REFERENCE: Taylor, Carla, editor. Groundwater: A Vital Resource, Student Activities. Knoxville: Tennessee Valley Authority, September 1985, pp. 42-44. ED 262 970.

BACKGROUND: This material may be presented as a lecture or in discussion format.

I. Sources of Nitrates

A. Natural

1. Animal Wastes

2. Fixation in Atmosphere. Since the atmosphere is 78 percent nitrogen (N_2), fixation is not uncommon during electrical storms where atmospheric oxygen (O_2) combines with the nitrogen to form a nitrogen-oxygen compound (NO_2). This compound then combines with rainwater to form nitric acid (HNO_3). The nitric acid reacts with soil minerals forming nitrates.

3. Fixation in Soil. Nitrogen-fixing bacteria on legumes account for most natural soil nitrates.

B. Addition by Man

1. Fertilizers--Since nitrates are essential for plant growth, many are added to the soil for agricultural purposes.

2. Wastes

a. Animal feedlots. While waste from an animal feedlot may be considered natural, the concentrations of these wastes on recharge areas may put an excessive amount of nitrates into the aquifer.

b. Septic tanks. It is estimated that 19.5 million septic tank systems put more than 800 billion gallons of waste water into the ground each year. In recharge areas, this waste water may reach the aquifer, accounting for excess levels of nitrates.

II. Dangers of Nitrates

A. In Drinking Water

1. An excessive level of nitrates may cause methemoglobinemia in children less than 6 months of age (methemoglobinemia is a "blue baby" syndrome).

2. Nitrate levels of 10 ppm (parts per million) or greater are considered unsafe by U. S. Department of Health Drinking Water Standards.

B. In Surface Water

1. Excessive nitrates in surface water tend to act in conjunction with phosphates to promote excessive growth of plants and algae. The death and subsequent decay of this life may deplete oxygen levels, making the water unsuitable for other aquatic life. Runoff is the major source of this pollution; excessive levels of nitrates in an aquifer would contribute to the problem.

ACTIVITY:

1. For demonstration of the effects of excessive nitrates on surface water, collect samples of water from various areas where nitrate contamination is likely to differ--for example, farm ponds vs. mountain streams. Or collect water from one source and add fertilizer to one sample while keeping the other as a control. In either case, the sample with the larger amount of nitrates should exhibit more rapid algae growth.

2. Determine concentrations of nitrates in water from various sources using a LaMotte Test Kit for Nitrates and Phosphates. These test kits are available from science supply companies.

DISCUSSION: After completion of this activity, ask the participants to:

1. explain the presence of natural nitrates in groundwater.
2. report on nitrogen fixation of legumes.
3. research the chemical reactions involved in converting atmospheric nitrogen to soil nitrates.
4. debate such things as animal feed lot location and limitation of use of fertilizers.
5. report on septic tank systems in terms of proper types for specific locations.
6. research methemoglobinemia.

HEAVY METALS

PURPOSE: To identify the processes involved in the detection of the presence of heavy metals in drinking water.

LEVEL: 10-12

FOCUS: Hazardous Materials in the Water

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, pp. 62-63. ED 254 443.

BACKGROUND: This activity is a simulation of how heavy metals are detected. Students will add galvanized iron (iron coated with zinc) and lead to water and later observe how toxic deposits are formed. The class should understand that although zinc itself is not terribly toxic, the presence of zinc in water can indicate lead and cadmium contamination also, since impurities of these metals are often found in zinc. Caution students not to touch the metal deposits. It is necessary to use distilled water and pyrex beakers so that reactions with lead do not take place. Because of such reactions, fewer incidents of lead poisoning are found in communities with hard water. A fourth beaker containing hard water could be used to demonstrate this effect.

Once again, stress the importance of good experimental design and the necessity of a control. Students should realize that positive results indicate the presence of some substance, but do not prove conclusively the existence of zinc or lead. Likewise, negative results do not mean the substances are not there, particularly because they are dealing with such small quantities. (Adapted from: Sootin, Harry. EASY EXPERIMENTS WITH WATER POLLUTION. N.Y.: Four Winds Press, 1974, pp. 86-89.)

ACTIVITY: Heavy metal deposits are often formed in drinking water after dissolving from pipes. These pipes are made up of galvanized iron, iron that is coated with zinc. The purpose of the following experiments is to see how these deposits are formed and how they can be detected.

Materials:

distilled water	3 medicine droppers
3 100 ml beakers	3 clean slides
straw	lead sinker
clean elbow of galvanized iron	steel wool
	3 watch glasses

Procedure:

1. Add about 50 ml of distilled water to 3 100 ml beakers.

2. Gently blow through the straw into each beaker for about a minute to carbonate and oxygenate water.

3. Add galvanized iron to one of the beakers.

4. After rubbing the sinker with steel wool and washing and drying it, place it in the second beaker.

5. Cover all 3 beakers with watch glasses, and set aside.

6. After 24 to 48 hours, place a few drops of water from each of the beakers on 3 clean labeled slides. Use one dropper for each or wash the dropper in distilled water between each.

7. Allow the drops to dry, and then examine the slides for any deposits.

Results:

1. Draw a sketch of the 3 slides.

2. Is there evidence of some heavy metal deposits? Explain.

3. Why is the beaker of plain water needed?

Discussion:

How might lead or zinc get into your drinking water?

TOXIC WASTE AND GROUNDWATER

PURPOSE: To determine the suitability of a landfill site.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Earth Science
Physical Science

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Goldman, Jill S., et al. Investigations: Toxic Waste, A Science Curriculum in the Participation Series. Cambridge, MA: Educators for Social Responsibility, September 1984, pp. 46-48. ED 254 443.

BACKGROUND: One of the major dangers of improper disposal or accidental spillage of toxic waste is groundwater contamination. Groundwater is under the surface of most of the country in aquifers, underground areas that can release water to springs or wells. There are two types of aquifers. One is relatively superficial and is found in layers of sand and gravel. Water generally flows slowly through these aquifers in the same direction as local rivers and streams. The second kind is in bedrock. Here the water flows through cracks and fissures as underground streams until it surfaces as a spring.

Many substances are soluble in water. Thus, all natural water supplies contain some dissolved material. Most of these substances, such as calcium or limestone, are harmless. However, many toxic substances can also be dissolved in water and will be added to the groundwater when rain percolates through the soil. Possible contamination of groundwater comes from town landfills, industrial waste sites, application of road salt, agricultural chemicals and pesticides, and accidental spills (such as leaks from old gasoline tanks).

Many town landfill sites were not chosen with these facts in mind. The contaminated water under landfills can flow several thousand feet in all directions from the landfill site. Furthermore, well pumping draws groundwater or stream or river water into well areas to replace the water being pumped out. If these sources are contaminated, then the water supply will become contaminated. Wells that supply the public are routinely tested for many substances, although new contaminants may go unnoticed. In private wells, which are

rarely tested, contamination is discovered through bad odors, discoloration of vegetation, and health problems of animals and humans.

What can be done to prevent further groundwater contamination? First, less toxic waste needs to be buried than is now. Much of it can be treated and may be recycled as useful substances (e.g., motor oil). Other substances can be incinerated and used to produce electricity. Finally, landfills should be built away from streams, wet lands, and aquifers, and should be contained by impermeable layers through which water does not pass readily. The purpose of the following lab is to compare the flow of water through sand and clay to determine which would be a better material on which to build a landfill.

ACTIVITY: The purpose of this activity is to demonstrate whether clay or sand would be a better material on which to build a landfill.

Materials:

fiberglass	clay-rich subsoil
2 funnels	red food coloring
sand	2 250 ml Erlenmeyer flasks

If sand and clay are not readily available in the soil in your area, check with your art department or artist supply outlet.

Procedure:

1. Put a fiberglass plug in the bottom of two funnels. Be careful handling the fiberglass. It can be an irritant.

2. Label one funnel "sand," and fill it with damp sand.

3. Label the other "clay," and fill it with clay-rich subsoil.

4. Place each funnel in a 100 ml beaker.

5. Put 2 drops of food coloring on the soil in both funnels.

6. Be prepared to time this experiment starting when you begin to pour water into the sand and clay and noting: 1) When the colored water appears in each flask, and 2) How long it takes to collect 50 ml of water. Read the questions in the result section so that you can time your experiment correctly.

7. Note the time and slowly pour water on the soils. As the surface dries, add more water. When 50 ml of leachate (the liquid leaching through the sand or clay) has been

collected, switch beakers and continue to collect it until the color is completely washed out.

Results:

1. How long does it take for color to appear from the sandy soil? from the clay soil?

2. How long does it take to collect 50 ml of leachate from the sand? from the clay? Calculate the rate of flow in cm^3/min.

3. How much water is needed to completely wash out the color from the sand? from the clay?

Discussion:

Compare your results with those of your classmates, and explain how the results justify the recommendation that landfills be built on clay.

GROUNDWATER CONTAMINATION IN A HAZARDOUS WASTE SITE

PURPOSE: To test for groundwater contamination, using a model landfill.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECT: Science

CONCEPT: Pollutants and contaminants are produced by natural and man-made processes.

REFERENCE: Llewellyn, Gerald C., et al. The Dilemma of Toxic Materials, Classroom-Tested Ideas and Resources for Social Studies and Science Teachers. Richmond: Virginia Commonwealth University, 1985, pp. 215-221. ED 263 015.

BACKGROUND: Hazardous wastes can result from mining, farming or industrial manufacturing processes. These waste products come from manufacturing of many vital products, yet these wastes can contaminate the groundwater if improper disposal occurs. It is the purpose of this lesson to provide some understanding as to how toxic pollution can occur from disposal sites.

Pollution has been defined as the addition of foreign matter to the natural environment to a degree which is not supported by nature. Not all pollutants are toxic. Toxic substance or hazardous waste pollution affects negatively the quantity and quality of living systems in the environment. A body of water is a dynamic system which constantly absorbs a range of solids, liquids, and gases, both those that are natural and those that are man-made.

There is a serious concern throughout the country and world about the purity of water supplies for both domestic and industrial use. It is virtually impossible to find any natural body of water that has not been affected either through the addition of man-made pollutants or through the manifestation of man's activities. There is an increasing demand for clean or unpolluted fresh water for a variety of purposes. Very often the water is of such low quality that it is not acceptable to the consumer, e.g., used for drinking water. Underground water is being contaminated more and more. In some communities the leachate from a "mid-night" created toxic waste site is moving through the soil at more than one foot per day (R. Tunley, "Time Bomb in Our Tap Water," Readers Digest, 126:90-96, January, 1985).

Natural waters teem with living organisms which can affect the ecosystem of a given body of water. All the substances, both

living and non-living, can flow, disperse, and interact chemically and physically before they reach a permanent settling point such as the ocean or a receptor such as a fish or crustacean. During the journey from source (above ground, leachate, underground and above ground again) to receptor, the substances may acquire a variety of chemical and physical forms. An example would be the mercury leaching into the Holston River in Virginia, and its change to methyl mercury. On the other hand, kepone, an insecticide, discharged into the James River, also in Virginia, is slow to break down but is continually becoming part of the sediment and then being washed out again on a seasonal basis.

Water is considered polluted, by one or more substances, if it is not suitable for its intended utilization such as agricultural and industrial supply, recreation, propagation of fish and wildlife, and domestic water supply. Scientists consider water pollution as the detection of specific undesirable agents and the depletion of oxygen with all of its consequences, while the general public takes a broader perspective.

What is groundwater? It is precipitation that has percolated down through porous earth and collected in layers of rock, sand, and gravel. These saturated formations are called aquifers, and they lie under almost every part of our country. They may be only a few inches to several miles deep in the ground. Groundwater may move very slowly and not cleanse itself as was previously thought.

Contamination of groundwater by toxic chemicals has become a major problem only being recognized in the 1980's. Irresponsible disposals, accidental dumping, poorly constructed but approved sites (Love Canal), and the recent influx of the criminal element seeking high profits from mid-night dumping are becoming serious problems to our water supply. Consider reading "Toxic Waste: Organized Crime Moves In," from Readers Digest, 125:73-78 (July), 1984. A landfill that begins to leak (leach) will present a serious hazard to our groundwater and to our health. This is especially true if well water is used by the nearby residents. A hazardous waste landfill is a burial site for unusable and dangerous chemical wastes but without any consideration for long-term protection of human health and the environment. But a secure hazardous waste landfill is much more than just a burial ground. It is a highly developed waste management method that uses proven procedures and techniques to provide total containment of hazardous materials, thereby protecting surface and ground-water from contamination.

The design concept of a secured landfill is quite different from that of a land disposal facility for non-hazardous

wastes, the conventional sanitary landfill. When hazardous wastes are disposed, the objective is to contain them completely for as long as they remain hazardous. A non-hazardous waste landfill is designed to control discharges of contaminants so that they do not cause or contribute to environmental contamination of groundwater.

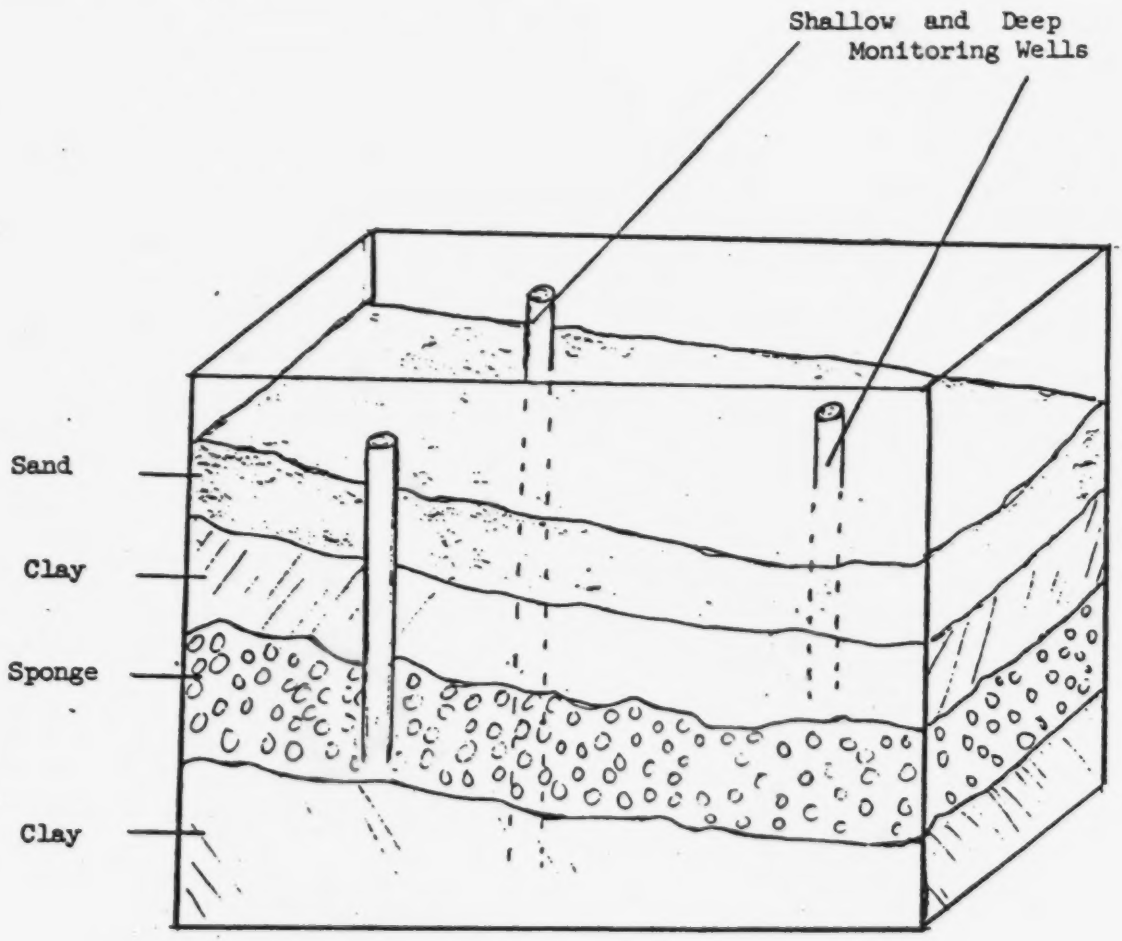
In essence, a secure landfill is a containment "envelope" typically made from thick, impermeable clay soils and/or synthetic materials. It is usually constructed in cells to segregate and isolate hazardous materials of different types. Clay, plastic liners, or other non-permeable materials are used to assure that the hazardous waste materials placed there never escape into the air, surface waters or groundwater. Wells are drilled nearby for continual monitoring of groundwater for leachate from the site.

A secure landfill is a safe and approved method for disposing of hazardous waste materials which cannot be treated by other modern methods now available. Some wastes may be too contaminated with heavy metals and other non-combustible materials to incinerate, too thick to inject into deep wells, too difficult or impossible to degrade chemically for harmless discharge into the air or surface waters, or not suitable to process for recovery of reusable materials or energy. A secure landfill is a method available for disposal of contaminated resides from the recycling, resources recovery, and incineration processes in which "something is always left over." The secured landfill-method is required and approved by the EPA but there are few approved sites available, and, of course, nobody wants such a site in their own backyard.

The "New RCRA" (Resource Conservation and Recovery Act), as approved by the 1984 Congress and under the direction of the EPA, will strengthen and limit some of the current disposal procedures.

ACTIVITY: Construct a model of a non-secured landfill in a small transparent box consisting of clay, a water saturated sponge, and sand (Figure 1). Use large glass tubing to construct several shallow and deep monitoring wells. Measure the time required for chemical contamination in the shallow and deep monitoring wells. Look for evidence of contamination and record results each day. Sample the wells with a long, "pulled" medicine dropper and test the contents of the sample with pH or litmus paper. Introduce each day into the center of the layer of sand and 10 ml sample of vinegar. Water colored with food coloring can be readily substituted and is safer and has less odor than the vinegar, but it will not cause the color change on the pH or litmus paper.

Figure 2. Model and Components for Student Landfill Construction Project.



Students may want to construct their own landfills, secured or non-secured, in plastic shoe boxes and use the box cover to retard evaporation. Straws of various sizes could substitute for the glass tube wells and the medicine dropper-sampler. Colored water should be added daily.

Materials needed for the above experiment include a transparent container such as a molded-glass aquarium, a plastic shoe box, an animal cage bottom, a gallon jar or a small aquarium. A tight-fitting clear plastic or glass cover is required. In addition, clay, sand, sponge or foam padding, glass tubing, colored chemicals or vinegar, long-stemmed medicine droppers, and litmus or pH papers are needed. We caution you about the substitution of other acids or bases for the vinegar or colored water. Even with the vinegar and water, be sure to use goggles and an apron when the liquid is handled.

The following are some technical suggestions for this activity. The glass tubing for the wells should be large enough to allow a medicine dropper to be inserted to remove samples of groundwater. The medicine dropper can be made from long pieces of small glass tubing by heating the glass and pulling it into a narrow opening. As reported above, a small straw could be substituted. Scatter the deep and shallow wells at random throughout the layers of clay, sand, and sponge. These wells should be placed into the sponge layer before the clay layer and upper sand layers are included. A secured landfill is constructed using a plastic liner, and it could serve as a control in the experiment, or it could have a few pre-planned punctures to serve as leaks. Introduce the colored water, dye, or vinegar daily on the top of the landfill to simulate rainfall and runoff water as it enters the soil and ground. Place a glass cover over the top of the model to prevent outside contamination and evaporation of the water and chemicals. Contamination will be evident in about 2-3 weeks depending upon how tightly packed you make the upper layers of clay and sand. Remember that the colored water will seep down between the container wall and the materials if it is not applied to the center of the model.

ADDITIONAL ACTIVITIES: Discuss the relationship of time required to contaminate the shallow and deep wells with the contaminating chemicals and their chemical and physical characteristics.

Discuss the amount of time needed for the secured landfills to become contaminated.

Discuss why some substances will allow rapid penetration and other soil-materials will not.

Have the student identify hazardous waste disposal sites and landfills in your area. Arrange for them to interview the management of such a site or have an EPA official or State Department of Health official visit your class. Consider having the State Water Control Board Enforcement Officer speak to your class.

Compare the function, effectiveness, and cost of a secured landfill to a non-secured landfill.

Develop a contest where students construct landfills of natural materials but without the liner. Then see which student's model is the most secured. Give prizes for the best landfill.

A TOXIC WASTES CASE

PURPOSE: To explore the problems associated with toxic wastes.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials
Social/Political Aspects

SUBJECTS: Social Studies
Science
Fine Arts

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Mann, Lori, and William B. Stapp. Thinking Globally and Acting Locally: Environmental Education Teaching Activities. Columbus, OH: ERIC/SMEAC, 1982, pp. 138-139. ED 229 214.

ACTIVITY:

1. Divide the group into teams of five to six members.
2. Distribute copies of the handout (page 232) and allow discussion. Have each group arrive at one plan of action.
3. Bring the teams together and share the results.
4. Debrief.

DISCUSSION:

1. How might the situation presented have been avoided?
2. How do toxic waste disposal problems affect people in other countries, particularly those near to the point of origin?
3. Do residents of the town in the activity have a responsibility to act? Why or why not?
4. Do the residents have a responsibility to people in surrounding counties? Why or why not?

A TOXIC WASTES CASE

You live in a town that is hundreds of miles away from any industrial center (like Detroit or Chicago). The town has a population of 3,000. The major income to the town has been tourism due to Blue Lake, a beautiful clear wilderness lake which is nearby.

Thirty years ago, in the early 1950's, your town convinced a chemical company which was looking for a site to build its plant in your town. The new plant would create 125 new jobs and bring in an $11 million tax base. In the early 1950's the resources of the lake seemed endless, while the prospects for economic growth of the town appeared all too limited.

Following is a chronology of events that occurred after the company broke ground:

1952 - Company breaks ground. Water Resources Commission grants waste disposal permit. Department of Natural Resources (DNR) conducts Blue Lake biological survey, finds healthy aquatic environment.

1955 - Chemical company calls waste disposal "major problem, due to local and state ordinances."

1956 - Company finds that soluble contaminants on the surface will quickly run into groundwater. Company prepares to manufacture C56, basis for pesticides Kepone and Mirex. State requests data on five chemicals discharged in C56 process. Company says it sent toxicity data; state says it never arrived.

1956 - 79 - Company produces 25,000 tons of C56 per year. No state regulator asks about residues. Meanwhile, company stacks 20,000 55-gallon residue drums in woods north of plant.

1973 - DNR surveys Blue Lake, finds trouble.

1975 - Company hires outside consultant to study groundwater. Tests show 10 percent concentration of firm's discharge water kills fish within 15 minutes.

1982 - Members of the community that live downwind of plant become more and more concerned about odors wafting from the plant. It smells odd, like laundry bleach and geraniums mixed together.

What do they - and you, as members of the community - do?

SANITARY LANDFILL

PURPOSE: To investigate advantages and disadvantages of a sanitary landfill.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECT: Science

CONCEPT: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Operation Survival Through Environmental Education: Senior High, Idea I, Land Manual. Environmental Education Project, Grafton, Illinois, Title III, ESEA. SE 014 502.

ACTIVITY: Population growth, convenience packaging and the projected increase of solid waste in the next ten years are contributors to a serious land use problem; i.e., solid waste. One of the most common methods of disposal is the open dump. This is not an acceptable method for many obvious reasons.

A better method than open dumping, that is becoming very popular, is the sanitary landfill. This method involves compacting the solid waste and covering it with a thin layer of dirt each day.

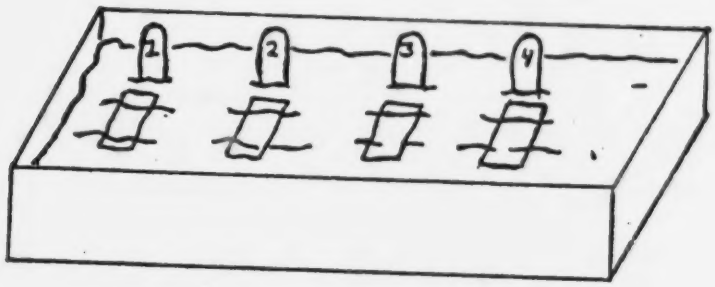
There are advantages and disadvantages of this type of operation. Instruct your class that you are going to run an experiment to determine what materials should be placed in a landfill.

Cut four strips, one by three inches, of one of the following items:

Saran wrap
Cellophane
Envelope "window"
Candy wrapping
Hard plastic
Styrofoam
Rubber
Carbon paper
Various food items
Tin can
Facial tissue
Paper towel
Typing paper
Ditto paper (with purple wax)
Notebook paper
Glossy magazine cover
Corrugated cardboard
Label paper from tin can
Aluminum foil

Collect garden soil in a deep tray, bread pan, or milk carton cut lengthwise. You might want to experiment with different types of soil. You will also need four markers, such as ice cream sticks.

Keep the soil moist but do not allow water to stand. Keep the samples at room temperature.



Observe and record on a data sheet the characteristics of the material used. Then bury and mark the four items in your garden soil. After each week, dig up one item and observe its appearance. CAUTION: do not disturb the other buried items. Look for the roughness of the surface as well as tiny holes or Swiss cheese-like holes, and complete disintegration.

After completion of this activity, answer the following questions:

1. Which samples disintegrate rapidly? Which show very slow disintegration?

2. Make a list of the samples going from the most actively disintegrated to the least easily disintegrated.

3. From the above list, what material should be recycled by salvage?

4. List some problems that occur at a landfill operation.

5. List problems to consider before a community initiates a landfill operation.

(Problems that should be considered are: pest control; i.e. rodents, flies pathogenic bacteria; odor; air and water pollution; appearance; i.e. windblown litter; economics.)

DEEP SEA TRENCHES AND RADIOACTIVE WASTE

PURPOSE: To determine the positive and negative aspects of dumping radioactive wastes into ocean trenches.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Earth Science
Physical Science

CONCEPTS: Certain risks are taken and limitations experienced when manipulating the natural environment.

Safe waste disposal, including reduction of the harmful and cumulative effects of various susbstances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: Stoever, Edward C. Jr. Deep Sea Trenches and Radioactive Waste, Teacher's Guide and Student Investigations, Crustal Evolution Education Project. Washington, DC: National Association of Geology Teachers, 1979, pp. 10-12. ED 216 925.

BACKGROUND: What would you do if you had to get rid of thousands of tons of used nuclear fuel (radioactive waste)? Where could you find a safe place to put it, a place where it could never hurt anyone?

This is not an easy question to answer. Many engineers and scientists all over the world have been trying to find an answer for a long time. Listed are five of the best ideas that scientists have come up with to get rid of radioactive waste -

- Put it in rockets and shoot it into the sun;
- Drop it into the mud in the middle of ocean basins;
- Store it in deep mines or caves;
- Place cans of the material on Antarctica, and let the heat generated melt its way deep down into the ice;
- Dump it into the deep ocean trenches.

Each of these ideas has both good and bad points. This activity considers dumping the radioactive waste into ocean trenches.

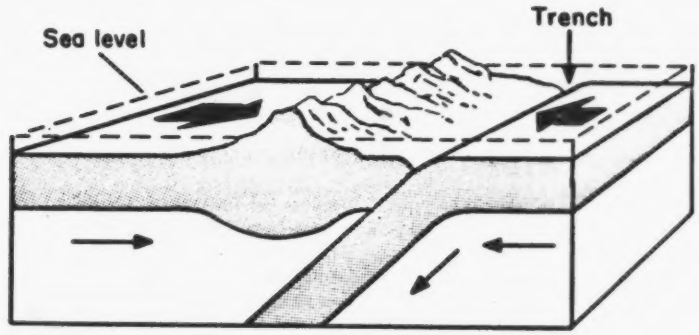
ACTIVITY: An ocean trench is a long, narrow depression with steep sides located on the deep-sea floor. Ocean trenches are located where the edge of an ocean plate is going down under a continent.

The scientists who suggest that radioactive waste be dumped into ocean trenches say that it will sink into the deep bottom of the trench and will be carried down and away forever.

Let's see what would happen if this plan were carried out in the Japan Trench. The descending ocean floor plate in the Japan Trench is subducting, or moving down, at a rate of 8 cm/yr. This rate is faster than most plates are moving. It doesn't actually move straight down, but at more of a slant or slope. Japan is located along the edge of the Eurasian continental plate, and the descending ocean floor plate slopes underneath this continental plate.

The worksheet (p. 238) is a cross-section of Japan and the Japan Trench. The Pacific Ocean is to the right and Asia to the left. Therefore, if radioactive waste material were dropped in the bottom of the trench at the place marked X, it should move down to the left with the descending plate.

It has been figured out that in 3 million years the part of the ocean floor plate now under the trench would move to a position 200 km to the west and 200 km down. Put an X on your graph to show where the radioactive waste would be then. In the next 3 million years, it would move 200 km more westward and 200 km more downward. Put an X at that spot. Put an X on your graph to show where the waste would be in 9 million years and in 12 million years if it kept moving at the same rate of 8 cm/yr. Draw a line through these spots, connecting them all together.



We are not too worried about what will happen to the radioactive waste 12 million years from now. Most of the waste will have decayed before then. When an element decays, it loses some energy and forms another stable element. This new element will be fairly harmless. But what about one-half million years from now? From your graph, can you estimate where the radioactive waste will be then?

1. a. In one-half million years, will the radioactive material have moved away from or toward Japan?

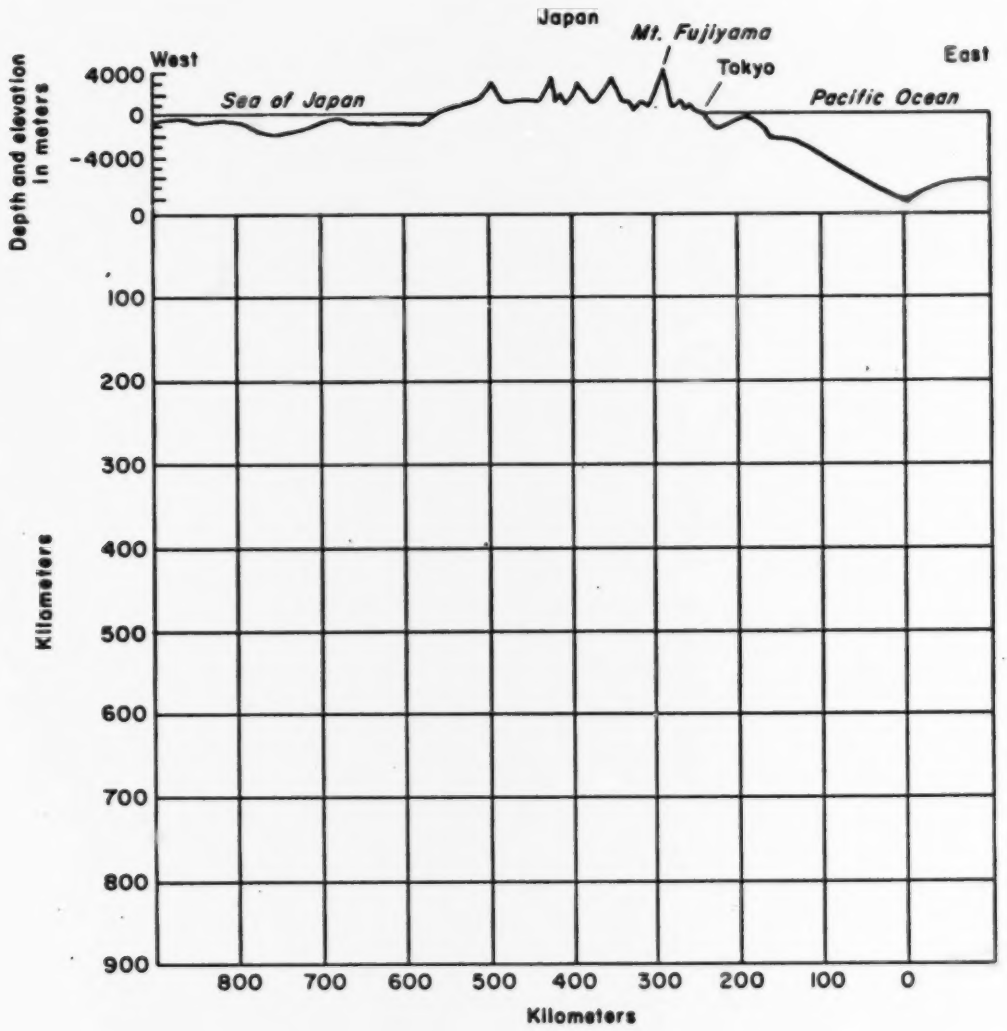
   b. About how much lower than the bottom of the trench will it be then?

2. Some of the ocean sediment on the subducting plate may be scraped off and added to the edge of the continent. What would this do to the radioactive waste?

3. The subducting plates are the cause of molten rock that pours out of volcanoes on the land behind the trenches. What would happen to radioactive waste that was in or on those plates?

4. What do you think of the idea of getting rid of radioactive material by dumping it into oceanic trenches?

WORKSHEET 12 FOR SECTION DEEP SEA TRENCHES AND RADIOACTIVE WASTE GOES HERE



STORAGE AND DISPOSAL - A RESEARCH PROJECT

PURPOSE: To explain and to evaluate types of storage and disposal methods and facilities for hazardous substances, particularly in reference to the local area.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Health
Environmental Science

CONCEPT: Environmental management is the result of the rational application of scientific and technical knowledge to achieve particular objectives.

Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: National Wildlife Federation. The Class Project, Conservation Learning Activities for Science and Social Studies. Washington, D.C.: NWF, 1982, p. 60, p. 73.

ACTIVITY: There are many different types of hazardous substances storage and disposal facilities. What is the design of the hazardous substances facility closest to you? Why was this design selected? Are there plans to update the present facility? What factors need to be considered when you design a hazardous substance storage or disposal area?

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HAZARDOUS WASTE: A COMPLEX INDUSTRIAL ISSUE

PURPOSE: To identify hazardous substances and the industries that produce them.

LEVEL: 10-12

FOCUS: Social/Political Aspects

SUBJECTS: Social Studies
Environmental Science

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

Safe waste disposal, including reduction of the harmful and cumulative effects of various susbstances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: National Wildlife Federation. The Class Project, Conservation Learning Activities for Science and Social Studies. Washington, DC: NWF, 1982, pp. 71-72.

BACKGROUND: Do your students know how to get the most out of interviews and how to put the person they interview at ease? In this and other investigations, your students become involved in finding answers to controversial questions. They might find themselves interviewing local public officials and businessmen about situations the people could consider threatening. In these situations, your students must practice tact and diplomacy. They will need to ask questions in such a way that the persons being interviewed feel comfortable and willing to give them useful information.

Do not avoid these controversial issues with your students. Encourage them to become involved and to use these situations to work positively with local officials and business people.

Make sure that they are prepared for interviews. They must gather information and "do their homework" before interviewing anyone. The following exercise will help your students identify threatening questions and avoid using them in interviews.

1. Ask your students to identify these questions as threatening or non-threatening:

   Just what do you think you are doing?
   What do you have there?
   May I help you?
   Is this a cover-up?
   What did I just tell you?
   Why don't you watch where you are going?
   I am trying to obtain information for a school project on hazardous waste disposal; would your department be able to help me with ... ?
   Do you want to call "60 Minutes" or Ralph Nader?
   How many times have I told you this?
   I need to find information on energy; can you send me anything?
   Why haven't I received my information?

2. Now ask the students to rephrase the questions so that those that were threatening are now not threatening, and vice-versa.

3. Have the class identify and list differences between the threatening and non-threatening versions of questions.
   a. What words help, and what words hinder open responses?
   b. How can a person construct sentences that sound positive?
   c. What phrases are there that defuse an interviewee's anxiety (by asking permission or reaffirming positive intentions, for example)?
   d. How can qualities of the method of delivery (politeness, sincerity, preparedness) contribute to the non-threatening nature of questions?
   e. What other general rules of etiquette need to be remembered when interviewing someone?

4. Let students apply what they have learned by making a list of hypothetical questions they might ask:
   a. the school principal, to find out why students can't leave the school grounds for lunch;
   b. a local merchant, to find out why he opposes a state law requiring the sale of beverages in refillable containers;
   c. a person at a local industrial plant, to find out if the company is following environmental regulations in manufacturing its product, and how it complies with those regulations.

ACTIVITY:

1. Work with your students to identify all of the manufacturers in your area. This information is listed in "The Thomas Registry of American Manufacturers," "Dalton's Directory," local Chamber of Commerce publications, or

state and local government economic agencies. (If you live in a major city, limit the boundaries of your study area.)

2. When local industries have been identified, have students find out what specific products are made by the company. How do we use the products and how do they benefit us?

3. Have students determine which local industries generate hazardous wastes, using the list of hazardous waste producers given in the introduction or the lists in pamphlets and publications you have ordered.

4. If you live in an area without much industry, conduct this investigation using the wastewater treatment plant or a local hospital. Sometimes the sludge from treatment plants contains hazardous wastes and must be disposed of in special ways. Some types of hospital wastes are also hazardous and require special treatment.

5. Once these industries have been identified, try to find out how each disposes of its hazardous waste. Each student or small group of two or three students can contact each company and request an interview with a company representative. The interviews could be in person or might be done over the telephone. The students should make sure that each representative understands that your class in interested in learning about hazardous waste disposal. As part of this activity, you may also want to invite a representative of one or more of the companies to visit your class and explain their company's waste disposal system. Before the actual interviews or before inviting representatives to class, it would be good for students to prepare a list of questions like the ones below. These could be submitted to each company ahead of time to set the tone for the interviews or visits. In this way, the company will have an opportunity to gather the information you are requesting.

   a. What types of hazardous substances does the company produce?
   b. How are they used in the manufacturing process?
   c. What are the health and environmental problems that can be caused by the substances?
   d. Do they dispose of them on site or transport them to other locations?
   e. Has the disposal of hazardous waste ever been a problem for the company?
   f. What regulations must be followed in proper disposal?
   g. What regulatory agency is responsible for monitoring their disposal system? How do they monitor it?

6. If company representatives cannot supply answers to these questions, have students contact the nearest EPA office, local environmental health offices, or a local environmental group for the information, particularly about state regulations.

7. The class may also invite representatives from EPA or other local community groups involved in hazardous waste disposal problems to the classroom. They could discuss their roles and compare the methods EPA recommends for proper disposal of a hazardous substance with those actually used by the business.

    a. Do EPA representatives feel that local companies are responding to the problems of hazardous waste disposal?
    b. Do the opinions or facts given by EPA representatives differ from those given by the company? If so, how do they differ?
    c. If there are no hazardous waste problems in your area, discuss the clean-up and regulatory process. How does the EPA representative monitor local industry?
    d. If no hazardous waste industries exist near you, what reason is there for this?

8. If you have a local hazardous waste problem which has appeared in a local paper, invite the reporter who wrote about the problem to class.

    a. Where did the reporter get his or her information?
    b. What is being done about the problem?
    c. What agency is responsible for cleaning up the problem?

Discuss the relationships and interdependencies of businesses with one another and with the community. Do any industries depend on any others for materials or parts? How do they contribute to the economic well-being of the community? What does the community or county contribute to the industry? What responsibilities does each have to the other? What would be the effects if industries were no longer able to operate in the community? What would counteract those effects?

SUMMARY: Ongoing discussion and comparison are very important throughout your students' research and interview processes. Provide many opportunities for discussion of the questions and issues listed here.

1. What similarities are there in the ways area firms dispose of their hazardous wastes?

2. Who is responsible for monitoring the disposal sites they use or operate? What proportion of businesses own and operate their own sites?

3. Did students feel that their interview techniques made their interviews more productive? In what ways?

Were there any situations in which the students didn't get the information they wanted? They might want to relate their experiences in as much detail as possible so that the class can analyze the situations--including questions, answers, and etiquette--and suggest more productive strategies for similar situations.

4. What monitoring techniques do area businesses or outside regulatory agencies use at the disposal sites?

Identify manufacturers which existed in your area 25 or even 50 years ago. What products did they manufacture? Decide whether or not these industries might have produced hazardous waste by comparing them to the list in the introduction to this section. Are these industries not operating anymore? Might there be pits at the sites which still contain hazardous wastes? If so, your students could find out who is responsible for the clean-up or, better yet, make sure local authorities are aware of the possible existence of these sites.

TOXIC CHEMICALS LIBRARY PROJECT

PURPOSE: To conduct a literature search on the concept of levels of toxicity and the physiological effects of selected chemicals.

LEVEL: 10-12

FOCUS: General Aspects

SUBJECT: Physical Sciences

CONCEPTS: Safe waste disposal, including reduction of the harmful and cumulative effects of various substances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

REFERENCE: Sollimo, Vincent. "Relevancy in Basic Courses: Considering Toxic Chemical Disposal." Journal of College Science Teaching, 14(3), December 1984/January 1985, pp. 193-195.

ACTIVITY: This assignment is to be completed and submitted to your instructor. Each problem is to be solved by using information found in a library search. An annotated bibliography should be included.

1. Cite an instance of chemical contamination caused by an industrial process that received national attention. Include how the contamination was detected, any adverse health effects, and what measures were taken to insure that such an incident could not recur.

2. Look up the chemical formulas of the compounds that follow, using a reference such as the "Merck Index," a chemical encyclopedia, or a reference for hazardous wastes. How do these substances enter the body, and where do they tend to concentrate in the body? Under the column entitled "toxic level," give the LD_{50} or any comparable data.

Chemical	Formula	Adverse effects	Toxic Level	Use
polychlorinated biphenyls				
vinyl chloride				
carbon tetrachloride				
DDT				
Malathion				
Dichlorvo				
Paraquat				
Agent Orange				
Dioxin				
Comments:				

3. Find an incident of local toxic chemical dumping and cite:
   a) The location of the site and the chemicals found.
   b) What adverse health effects occured, if any?
   c) What is being done to rectify the problem?
   d) What do you feel should be done by the federal or local government to deal with toxic chemical problems?

STUDENT SURVEY OF A TOXIC CHEMICALS UNIT

PURPOSE: To summarize learning taking place during a unit of study on the toxic chemical waste issue.

LEVEL: 10-12

FOCUS: General Aspects

SUBJECT: Physical Science

CONCEPTS: Safe waste disposal, including reduction of the harmful and cumulative effects of various susbstances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

REFERENCE: Sollimo, Vincent. "Relevancy in Basic Courses: Considering Toxic Chemical Disposal." Journal of College Science Teaching, 14(3), December 1984/January 1985, pp. 193-195.

ACTIVITY: At the completion of a unit of study of the toxic chemical waste issue focusing on the health hazards posed by such chemicals that enter the soil, water, and atmosphere, these questions may be posed:

Question 1. How do you describe your awareness of this issue: (a) before studying this issue? (b) after studying this issue?

Question 2: How do you react to media (TV, radio, newspapers) references to the toxic chemicals issue? Has your awareness of and familiarity with these references changed since studying the issue?

Question 3: Considering the scientific/technological problems that have local and national health impacts--for example, radiation or genetic engineering--how would you rate the toxic waste issue in terms of priority: Highest, average, or lowest? Why?

Question 4: Assuming that you feel strongly about this issue, would you be willing to take part in a local or national organization that is concerned about public health?

Question 5: Concerning the toxic substances: (a) What was the most valuable information that you gained? (b) How would you change the toxic substances project?

DOWN IN THE DUMPS

PURPOSE: To explore the disposal methods that have caused problems in several cities, and the cleanup methods used to alleviate the problems.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Environmental Science
Social Studies

CONCEPTS: Responsibilities for conservation should be shared by individuals, appropriate levels of government, business and industry, special interest groups, and all levels of education.

Certain risks are taken and limitations experienced when manipulating the natural environment.

Safe waste disposal, including reduction of the harmful and cumulative effects of various susbstances and forms of energy, is important if the well-being of humans and their environment is to be preserved.

REFERENCE: National Wildlife Federation. The Class Project, Conservation Learning Activities for Science and Social Studies. Washington, DC: NWF, 1982, pp. 63-64.

BACKGROUND: Many of us are not aware of the great numbers of items produced commercially for which hazardous substances are by-products. Anything containing synthetic rubber, paper, or plastic involves hazardous substances in its production. As a technologically oriented culture, we depend on products like these. To help your students understand how this technology affects their lives, make a list of the products/goods used in your classroom. You may want to focus student attention on kinds of things that might be particularly interesting to them: recreational equipment, hobby materials, or clothing, for example. After students have generated a complete list, make two columns with the headings "Hazardous Substances" and "Non-hazardous Substances."

Students are to separate the lists of all products in their classroom into one of the two categories, depending on whether or not they **believe** hazardous substances are products or by-products of the manufacturing process. Don't forget to include books and materials, and other items common in the classroom. At the end of this investigation, your students

should review their lists and make changes based on what they have learned in the investigation.

ACTIVITY:

1. Listed below are the locations of some hazardous substance disposal sites which have caused problems. Ask each student to choose one as a research topic. Do any students know of other, similar sites they would like to study?

   Love Canal, New York
   New Egypt, New Jersey
   Valley of the Drums, Tennessee
   Elizabeth, New Jersey
   Woburn, Massachusetts
   Lowell, Massachusetts
   Bumpass Cove, Tennessee
   Lekkerkerk, the Netherlands
   Greensboro, North Carolina
   Sharptown, Maryland
   Gary, Indiana
   Rocky Mountain Arsenal, Colorado
   St. Louis Park, Minnesota
   Muskegon, Michigan
   Hopewell, Virginia

2. Some of the best sources of information about hazardous substance disposal are newspaper and magazine articles, television, radio, and publications available from government and environmental organizations. "The Reader's Guide to Periodical Literature" is the best source of information for magazine and newspaper articles. However, most of the locations listed in #1 will only appear in "The Reader's Guide" under the following headings:

   Poison and Poisoning
   Chemicals - Law and Legislation
   Radioactive Waste Disposal
   Environment
   Pollution
   Love Canal
   Benzene
   Bumpass Cove, Tennessee
   Hazardous Substance Disposal
   Toxic Substances
   Dioxin (TCDD)
   Agent Orange
   Resource Conservation and Recovery Act
   Toxic Substances Control Act
   Toxic Chemicals
   Kepone
   Hazardous Wastes

3. Students may develop time lines charting the history of each hazardous waste disposal controversy. Their research should include:

   a. the date the disposal site was opened;
   b. the dates of specific events, such as:
      1. when disease or physical abnormalities first appeared,
      2. when these physical problems were first linked to the disposal site,
      3. when local water was first tested showing the presence of toxic substances,
      4. when municipal and company hearings were held,
      5. when legal action was first taken,
      6. when the problem was solved.

4. In addition to the time line, your students could prepare accompanying reports or explanations for the following aspects of the problem:

   a. What substances were causing problems at each site?
   b. What health problems are usually associated with the substances?
   c. Currently, what disposal methods (if any) have been approved for the substances by state or federal agencies, or by manufacturers? What methods were approved when the problem first surfaced?
   d. What products require the use of the hazardous substances in their manufacture?

5. Some of your students may prefer to research the chemicals themselves and their products:

   a. When were the chemicals first developed or discovered?
   b. What health problems do the chemicals cause?
   c. How long have the chemicals been in use?
   d. When (if at all) were regulations restricting their use drawn up and implemented?
   e. When did producers first begin using or disposing of the chemicals?
   f. When and how have companies that use or produce the chemicals reacted to complaints?
   g. When did the EPA recommend specific treatment methods?
   h. In what production process(es) is the chemical used?

6. Some students could be assigned to research the Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act (TSCA). The information they gather about each law should answer these questions:

a. When was each act passed?
b. What government agency is responsible for enforcing the acts?
c. What is the purpose of each act?
d. What hazardous wastes are covered by the Resource Conservation and Recovery Act?
e. Why are radioactive wastes **not** covered by the Resource Conservation and Recovery Act?
f. What toxic substances are not covered by the Toxic Substances Control Act? Why not?
g. What general regulations are covered by each act?
h. Whose responsibility do students believe it is to regulate or clean-up toxic waste dumps? What are the options?

Do students believe that Superfund-style legislation can provide an answer? (RCRA does not supply funds for the clean-up of abandoned dumps. Money could be appropriated by Congress as a superfund for this purpose.) Have funds been appropriated?

SUMMARY: Compare the time lines.

1. Which sites have been most successful in dealing with their problems?

2. At which site have the residents suffered the most serious illnesses and symptoms of hazardous substance contamination?

3. At which site have the people experienced the most difficulty in settling the problems?

4. At which site were the chemicals dumped most recently? The earliest? Does there seem to be a relationship between the number of physical problems and the length of time the chemicals have been at the site?

Now that your students have identified industries which use or produce hazardous substances in their manufacturing processes, go back over the list they made at the beginning of this investigation in Setting the Stage. What items form their "Non-hazardous Substances" list should now be added to the "Hazardous Substances" list, and vice versa? The following questions may help your students understand the relationship between our industrial/technical society and our standard of living:

1. Can you think of substitutes for the product or alternatives to the industrial processes used to make some of the products common in the classroom?

2. Can you think of alternatives to the toxic chemicals we use? For example, what can be used instead of pesticides to control insects?

3. What are the "costs of progress?" Is our progress as a nation worthwhile in the long run if one of the "costs of progress" is as threatening as hazardous waste?

WHAT DO YOU DO WITH WASTE CHEMICALS? A DILEMMA

PURPOSE: To determine strategies and solutions for disposing of toxic waste chemicals.

LEVEL: 10-12

FOCUS: Disposal of Hazardous Materials

SUBJECTS: Social Studies
Biology
Chemistry
Environmental Science
Earth Science

CONCEPT: Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

REFERENCE: Iozzi, Louis A., et al. Environmental Dilemmas: Critical Decisions for Society, Student Guide, Preparing for Tomorrow's World. New Brunswick, NJ: Rutgers University, Center for Coastal and Environmental Studies, 1980, p. 93.
ED 230 373.

THE DILEMMA:

Robert Hughes became concerned about the dumping of industrial chemical waste into deep wells close to the major river of his state. He began searching for a more environmentally safe way to dispose of these wastes. Together with a soil researcher, he developed a biodegrading technique that used soil to break down chemicals into safe compounds. He then formed a company, purchased 6000 acres in the desert, and secured a contract with a chemical company to haul away and dispose of its toxic wastes.

Soon after he began hauling the chemical waste to the disposal site, the state enacted new rules for the storage and disposal of hazardous chemicals. The new rules required that companies handling hazardous chemicals obtain a license for $5,000 and post a $200,000 cash bond. Mr. Hughes did not have such a large sum of money. Moreover, it turned out that the chemicals were so highly toxic that a much more expensive technique was required to detoxify the materials. Under these new conditions the company could not operate.

Mr. Hughes now had 600,000 gallons of very poisonous chemicals in metal drums standing in the middle of the desert. Since he did not have a license to dispose of the waste by his new "soil" method, the state ordered him to bury the waste in underground trenches within one week. The state claimed that it was safe to bury the waste. Mr. Hughes, however, was sure that the chemicals would leak into and poison underground fresh water reservoirs.

Should Mr. Hughes comply with the state orders? Why or why not?

SAMPLE OPINIONS

Marion "Yes, what else can he do? If that's what the state orders, then its his duty to comply. They left him with no other alternative. He doesn't have the money for the expense of using the biodegradation method. He should do what the state officials ordered and leave the rest up to them. It's no longer Mr. Hughes' problem. It will be the state's responsibility if anything happens now."

Bill "Yes, Mr. Hughes should do what he was told by the state officials. The state made the laws and they are charged with enforcing those laws. Mr. Hughes, if he is to be considered a law-abiding citizen, has no choice but to obey the laws of the state. What if Hughes disobeyed the state's order? Maybe that wouldn't be too bad. But what if everyone did it? You see, Hughes would be setting a bad example. This order was given to prevent dangerous materials from causing injury. The law is always right."

Pete "No, I don't think that he should obey the law. While rules or laws are usually fair and made to protect people, sometimes certain laws are not made wisely. In this case it is obvious that the state does not understand nor recognize the danger to human health that dumping the chemical will cause. I think the state officials are acting hastily in this situation. If Mr. Hughes thinks that there is a chance that the buried chemicals could poison the waters, he should not comply with the order. What is more important than to try to protect the health and safety of people?"

DISCUSSION QUESTIONS

- o In terms of society's welfare, which would be worse: disobeying the law or burying a chemical in a way that might be harmful? Why?
- o Since Mr. Hughes owns the land, shouldn't he be allowed to do what he wanted on it? Why or why not?
- o If the chemicals should leak into the fresh water reservoirs who should be blamed? The chemical company? Mr. Hughes? The state? Why?
- o Isn't the state trying to protect people from unsafe disposal of chemical waste by imposing such a law? Why or why not?
- o If Mr. Hughes was so concerned about toxic chemical waste, shouldn't he try to raise money for a license? Why or why not?
- o Since Mr. Hughes' intentions are so good, do you think that the state should consider allowing him to operate without paying for a license and a bond? What would people think about laws if the state made an exception for Mr. Hughes and allowed him to operate without a license? Why?
- o If a person takes on a responsibility should he/she try his/her best to complete it, no matter how difficult? Why or why not?
- o If Mr. Hughes defies the state order, should he be sentenced to jail? Why or why not? What effect would that have on society?
- o What should be Mr. Hughes' most important consideration in making the decision? Why?

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